THE

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THE HEILMANN LOCOMOTIVE.

Mr. LEA'S objections to our criticism on the Heilmann electric locomotive appeared in our last number, and we are sorry that, owing to an ambiguity in Mr. Lea's own description, we described Mons. Heilmann as of the Chemin de fer de l'Ouest. As he appears not to be so, we can only affirm our astonishment that the locomotive found constructors.

We do not understand Mr. Lea's references to the £. s. d. value of the *pros* and *cons*, not, at least, so far as the statement *re* coal consumption. Granting, for argument's sake, that a locomotive does burn from 4 to 8 lbs. of coal per horse-power hour, including lighting up, &c., we cannot see how this amount is to be reduced by the Heilmann engine. We perfectly appreciate that a stationary condensing compound engine would generate electricity for less than the above supposed rate of locomotive consumption, but this is altogether beside the question. We have never questioned the possibility of electric traction; the Liverpool railway exists, as does also the City and South London, and we certainly do not need any such contrivance as the Heilmann engine to demonstrate that an axle may be revolved by an armature. But the Heilmann engine is not a condensing stationary engine. It is simply a high pressure steam engine carried on a moving platform, and no way better calculated for good results than the engines of the ordinary locomotive. There is absolutely no value in the contention that such a portable engine will prove more economical than the ordinary locomotive, which can as well be made compound as the Heilmann engines. That side rods may advantageously be dispensed with we certainly do not doubt, and it is just here that the weak point of the ponderous Heilmann affair comes in. There is no marvel whatever in the Midland single engines hauling the Midland trains. A single pair of drivers at high speeds will adhere, it is probably quite accurate to say, to the tune of 700 horse-power. The "Gladstone" of the L. B. & S. C. Railway showed 667 horse-power at 47 miles per hour when hauling a total load, including itself of 335 tons, up a grade of 1 in 330,* and burning coal at the rate of only 24·87 lbs. per mile, exclusive of lighting up. The engine has cylinders 18½ inches by 26 inches, and coupled 78-inch wheels carrying an adhesion load of about 28¼ tons. We believe these results are quite equalled by the single engines of the G. N. or Midland, and Mr. Lea, who knows the North-Eastern singles, must know what they have done and how poor an argument it is to bring up the abolition of coupling rods as an argument for fast running when the best work in this country is done without them. Mr. Johnson, of the Midland, it is true, stood out long for coupled engines, but we do not think he has had any reason to regret his newer design, and we do not believe that Mr. Stirling is in any way surprised at others finding out what has

* *Minutes Inst.C.E.*, Vol. 81.

been patent to him for 20 years. As regards the exposure of working parts to dust, this, if sufficiently serious, could be prevented by boxing in, as is done on the "Loughborough" tramway engine. We were certainly not in particular earnest in suggesting ropes as a means for connecting an engine with the driving axles. We only suggested this as an improvement upon the double transformation of the Heilmann engine, though there need be no reason for ropes to flap round in dust and dirt. In ordinary railway work the engine does not run much in dust, though the following carriages may do so, and ropes are used in cement works and other places quite as objectionable. Still, we only wished to suggest them as an improvement. The crux of the matter is this: can it be shown that granting an electrical efficiency of 70 per cent. any engine can be designed for a travelling platform which will be as economical in fuel as a locomotive burning about 17 lbs. of coal per mile? Simply placing the cylinders transversely will not affect the economy, nor can we see how a steam engine can very well be designed to give better results than are obtained with the arrangement of parts ordinarily followed in the locomotive. At high speeds it has several distinct advantages that make for economy, viz., high piston speed, rapid reciprocation, compression of exhaust and favourable cylinder position—at least when inside the smoke box. In fact, the locomotive is an acknowledged economical engine when running, and all the incidental losses, such as lighting up, and standing in siding, will be fully as great in any system involving a locomotive boiler.

To suggest that the Heilmann engine will accustom railway men to the possibilities of electric traction is rating them rather low down and about on a par with the use of the dummy car to ease the minds of horses. We fear that the attempt will rather tend to bring the advocates of electric traction into contempt. The whole thing savours too much of playing at electric railway. It is somewhat on all fours with the case of the engineer who declared a railway in the Low Countries to be impossible, because there was "nowhere to run the tunnels," and who compromised by building a covered way so as to get into line with precedent—no railway then built being without its tunnel.

HIGH FREQUENCY.

Lieut. F. J. Patten has recently called attention to his proposal for obtaining high frequency by means of generators coupled in series, the armature of the one to the field of the next, and so on. Evidently he is one of those inventors who believes in, and expects to get light without heat, from electrical energy transmitted at high frequency. The late Dr. Hertz, and the experiments of Tesla, have led some electricians to believe that if an electro-magnetic frequency equal to the frequency of the vibrations of light could be set up by a generator, the waves would then be light waves. No doubt the electro-magnetic waves would be light waves, as proved by Hertz, but it is quite easy to prove that at frequencies considerably less than the frequency of light vibrations, all known conductors of electricity become perfectly opaque to electric current waves. Electricity at such high frequency could no more pass through a copper wire than light could, for conductors become practically insulators at frequencies which are quite low compared with the frequencies of light vibrations.

It is quite probable that frequency as rapid as light waves can be set up by some generator of alternating current; but such a current could not be distributed by any means now known to electricians, and the light, if any, would be radiated only from or near the generator.

It seems that the electricity must always be distributed, as it is at present, at conductible frequency, and that any attempt to produce electro-magnetic waves of a frequency equal to light waves, must be made at the point where the light is required. This points to the conclusion that if the problem is to be solved by setting up electro-magnetic vibrations by means of electric current waves, these must be produced in or at the lamp, or in whatever is to replace the lamp. The problem is, therefore, not to construct an electric generator for the high frequency, but to invent a converter to produce high frequency from low frequency or from continuous currents; and it may be quite possible to produce high frequency electro-magnetic waves by means of low frequency electric current waves.

High frequency experiments are generally safe on account of this property of conductors refusing to allow high frequency current to pass freely in any dangerous quantity.

In treating of high frequency phenomena, electric current waves and their properties must be carefully distinguished from electro-magnetic waves. However electric energy may be propagated, we know that current is always dependent upon a wire or some conductor, while electro-magnetic waves of any frequency can pass freely over space or through the insulators.

A Fluid Interrupter for Producing High Frequency Currents.

The maintenance of regular oscillatory discharges, such as are necessary for practical working with high frequency currents, for any length of time is a difficult matter. The spark gap through air lends itself readily to irregular and uncertain action. It may easily develop into a continuous arc, and even if this does not happen the discharges are apt to become spasmodic, with intervals far from constant. Mr. Tesla has introduced a device to overcome this difficulty, which consists of an automatic fluid interrupter which takes the place of the air gap. The sparking arrangement, as well as the coils, is immersed in oil. It consists of a turbine with blades which bridge the space between the two terminals, so that they nearly or quite touch them as they move. The turbine is caused to revolve by means of a pump which is in connection with a series of tanks and pipes, so that the oil is kept in a state of circulation. The rate of discharge is thus controlled by the pump, and the oil is prevented from heating. It will be seen that the interruptions and consequent discharges can be made with great regularity, and, further, that they become practically silent. This device seems to do much to obviate the difficulties surrounding the practical use of Teslaic currents, but it is somewhat elaborate and may introduce difficulties of its own. It will be interesting to observe how it stands the test of practical working.

THE HERMITE SANITARY PROCESS.

In this process it is proposed to supply electrolysed sea-water, or an electrolysed solution of common salt and magnesium chloride for public purposes, such as flushing sewers, washing streets, &c., and also to houses for closets and sinks.

Such a scheme has a good deal to contend with. First, in most towns, a good fresh water supply already exists, and it is quite apparent that such a supply is successfully used for all sanitary purposes, except that of disinfecting. The disinfecting in such cases, where necessary, is usually effected by adding chemical compounds to the sewage at some point in the system of drainage. In most cases, however, the addition of chemicals is not resorted to, other means being taken to destroy the objectionable matter.

Sea-water itself is antiseptic, and is, to some extent, a deodoriser, and at various times proposals have been made for a public supply of sea-water in large towns for sanitary purposes, notably in Glasgow, but the advantages on close investigation, have always appeared so slight, compared with the enormous cost of pumping and distribution, that the schemes have invariably been abandoned.

In the Hermite process, besides the cost of pumping up the sea-water above the level of the highest point in the town to be supplied, we have the added cost of the electrolysing process; what that is we, at present, cannot ascertain further than by making a rough guess at the power as being about one horse-power working continuously for each 500 head of the population. This is not much, perhaps, but it is an addition of importance in total costs.

In towns away from the sea it is proposed to add chloride of sodium and magnesium chloride to fresh water, to electrolyse that solution and then distribute it. It seems to us that if chemicals are to be added to water for this purpose, it would be cheaper and less roundabout to add the disinfecting chemicals in the first instance, and save the cost of electrolysing; any chemicals produced by the electrolyser can be substituted by ready made disinfectants, such as can be added to the water as required.

The question, then, narrows down to several issues: First, whether a separate antiseptic supply of water is advantageous for sewage purposes; second, whether the antiseptic chemicals are cheaper prepared by the electrolysis of other chemicals in solution, or by adding antiseptic chemicals already prepared to the water supply for sewage purposes. The answer to the first question we leave to sanitary engineers.

The second question, we think, depends for its answer on the position of the town. A town with a plentiful supply of water by gravitation, even if situated by the sea, might get its disinfecting supply much cheaper by adding chemicals to the fresh water in a reservoir, and thereby save the pump- and electrolysing of the sea-water.

A town removed from the sea must consider whether the electrolytic or chemical mixture methods of producing an antiseptic water supply is cheaper, bearing in mind that chemicals must be mixed with the water for the electrolytic process. It is stated that only the magnesium chloride in the sea-water is decomposed in the Hermite process; and that the sodium chloride serves only as a conductor. Such a statement made by the promoters of the scheme is enough to throw suspicion on the proposals of the inventor. Sodium chloride cannot serve only as a conductor in the solution; if it did it would certainly be a very unfortunate thing for the Hermite process. If the sodium chloride conducts any current without electrolysis, then so much current is absolutely lost, wasted power. It may be taken as a fact that if the sodium chloride is not decomposed, no current passes through it, and the process on that account is not so bad as its friends would make out; the little prospectus with this mistake in it ought really to have been submitted to an expert for correction.

Just exactly what chemical actions and reactions go on in the Hermite electrolyser, it would puzzle the most learned chemists and electricians to state, but it is certain that any compound in the solution by which the electric action passes must be decomposed. Sea-water is a very complex electrolyte, and very different results can be obtained by electrolysing such a mixed electrolyte at different electric pressures. Different sizes of electrodes even, will produce different compounds, and different compounds will be formed if the electrolyte is kept still in one experiment and stirred continually in the other.

Electrolysed at a low pressure, say, not over 2·5 volts with large electrodes, and kept still, magnesium chloride only would be decomposed at first, the magnesium taking up oxygen at one pole and liberating hydrogen there, while the chlorine would be set free at the other pole. This chlorine would, when it came in contact with the oxidised magnesium, combine therewith and form magnesium hypochlorites. To bring them into contact in the Hermite process, a mechanical stirrer is applied; these chlorine compounds formed with the oxidised earthy metals, are the active antiseptic materials in the Hermite process. But, in the process as shown at Worthing by Messrs. Paterson and Cooper, the pressure used was 6 and never less than 5 volts. The electrodes were small for the current—300 ampères—and the liquid was continally kept in rapid motion; under these conditions it is safe to say that every electrolyte in the sea-water is acted upon electrolytically, and that the result of all the decompositions is much modified by the recompositions of the various products brought into contact again in the liquid, the final result being a copious evolution of hydrogen (which might be utilised) and the formation of "oxygenated compounds of chlorine," and not "an oxygenated compound of chlorine" as the promoters put it.

Such an electrolysed solution would not keep long, it would gradually change back into its originals. It would, therefore, be much more efficacious if used as produced, and then no doubt it has all the solvent disinfectant and cleansing properties claimed for it.

There was little to see and less information to be got at Worthing regarding the strictly scientific aspects of the process. We understand the inventor is to read a paper on the subject, and from that we hope to gather some exact knowledge of the chemical and electrical results of his experiments.

Although the process may not be adopted for sanitary purposes, it may be of value for other industrial applications; and we believe it has met with some success as a bleaching process.

The whole subject of the electrolysis of mixed electrolytes is one still in much obscurity and presents a promising field for the investigator. Secondary actions of great import, and quite unexpected, are often observed in experiments with complex mixtures or compounds under various electric pressures and other conditions.

ADVANTAGES OF DIRECT CONNECTED DIRECT CURRENT GENERATORS.*

By W. N. STEWART.

For a model generating plant of 500 H.P. the following apparatus should be installed: One multipolar generator of 100 H.P., running at about 250 revolutions per minute, directly connected to a compound engine of the same speed. One multipolar generator of 400 H.P., running at about 170 revolutions per minute, directly connected to a compound engine of the same speed. In most cases condensing apparatus is to be used where water is available. These dynamos are to be made for 220 volts if the three-wire system is used, and for 480 volts if the five-wire system is employed; three-wire distribution to be employed where the distances are not over one mile from the power house, and five-wire where they exceed one mile.

Additional apparatus, as follows, would be necessary: For three-wire system, 120 cells of storage battery, each cell having a capacity of 30 ampères for 15 hours; for five-wire system, 240 cells of battery, same size. This storage plant to be used as an equaliser and regulator, and to furnish current during the day. Necessary switchboard apparatus, including an automatic regulator for dynamos, would also be necessary.

* Abstract of a paper read before the North-Western Electrical Association, Milwaukee, January 17th, 1894.

The wiring would be as follows: One circuit of mains and feeders for commercial and house lighting. This would supply all private consumers with arc or incandescent lighting or motive power; each customer to have a meter. All motors to be connected to the outside wires of either three or five-wire system.

To operate this plant we would employ but two men—one engineer and one fireman. The station would have a superintendent and lamp trimmers as necessary for the number of arc lamps used. The public arc lamps would be wired as follows: If three-wire system is used, a common neutral wire would be supplied for both public and private lights; this neutral being thoroughly grounded at various points. Thus but two wires would be run for the public lighting; the arc lamps being connected in groups of two between the positive and neutral. If the five-wire system is used, the arc lamps would be run in groups of eight, each lamp having an automatic cut-out. To run arc lamps on a constant potential circuit it is necessary to have a certain amount of resistance in the circuit to steady the arc; this resistance should be in the line wire, iron wire being used in some cases, or copper wire not smaller than No. 8.

Technical men say that this is a waste of power, but the author thinks this loss in resistance is overrated.

If the ordinary arc dynamo gives 78 per cent. efficiency and the constant potential machine 95 per cent., we have a difference of 17 per cent. in favour of the constant potential machine. The resistance necessary to work the low tension arc lamps never absorbs more than 15 per cent. of the current, so that we have an advantage of 2 per cent. in favour of the system which I am describing.

But we have still another gain; the ordinary arc dynamo runs at about 900 revolutions per minute and must therefore be belted to the engine. The friction of this belting and high speed dynamo must be taken into consideration. If one belt direct from the engine is used, 10 per cent. is lost; if a countershaft is used, 18 per cent. is lost. So that is one case where we gain 12 per cent. in our power bill, and in the other 20 per cent.; and this is not theory, it is being done every day in the State of Wisconsin, and adjoining States.

The operation of such a station would be as follows: The small dynamo would be started no later than four o'clock in the afternoon, most of its current being absorbed by the storage battery; as darkness approaches, the large dynamo would be started, its current being divided between the customers, streets, and storage battery, until all the lights are burning, when the battery would simply act as a regulator. This engine would run steadily until two o'clock in the morning, the last four hours being principally devoted to charging the battery. Thus the *employés* would have a daily run of 10 hours, and the engines would always work at maximum efficiency for the full run. The battery would do the work 14 hours daily. It may be well to state here that storage batteries are now being used in most European stations, and in three or four of the largest American stations with good results, and that batteries can be had which infringe no patents, and which are thoroughly reliable in their action.

We have a station which is made up as follows: One machine in operation at one time, doing all our work, that machine having an efficiency of 95 per cent. with no losses in belting or shafting, running at slow speed with consequent minimum of cost for repairs. A daily run of only 10 hours, thus getting the best possible service from *employés*. Current available day and night for all persons. A machine which does not burn out, and which can be repaired in three hours. Low pressure wiring, therefore no damage suits for loss of life. Longer life and less blackening of incandescent lamps, as the battery gives a current absolutely uniform at all times. Less real estate and buildings required. Less liability to breakdowns. No burned-out armatures. The average cost of burned-out armatures on arc machines in 77 cities was, last year, $2.14 per arc lamp. Less oil; fewer *employés*; no losses in transformers, or other subsidiary apparatus.

The author asserted that an economy of 40 per cent. could be thus obtained over the old-fashioned methods, and cited several instances of existing plants to substantiate his statement. In conclusion, he said that facts, as observed by him in this country and Europe, lead him to reiterate his belief, founded on 23 years' work in the electrical business, that it is the direct current stations which are paying the dividends.

ELECTRICAL LITIGATION.

Two cases have recently occurred in France in which electrical installations have been suppressed to please the local gas companies. The decrees, however, have in each case been set aside on appeal to the Court of Cassation. The first case was at Sedan, where the Maire had authorised one M. Colette, to instal in the public streets leads and other appliances needful for the supply of current to private houses, and for the transfer of motive power. Thereupon the gas company sued the town for damages, and obtained from the Council of the Prefecture a decree in its favour.

In consequence, on September 15th, 1891, the Maire issued a decree revoking his previous authorisation and ordering M. Colette to remove his plant. M. Colette resisted this decree, and on October 24th and 25th he was accordingly summoned before the police court of Sedan, and sentenced to a penalty of 1 franc, and to remove his cables.

M. Colette was still a recusant, and was in consequence cited before the Correctional Tribunal, which confirmed the judgment of the police court.

M. Colette now appealed to the Court of Cassation, which, on July 27th, set aside the decrees against him. We suppose the Maire of Sedan and the gas company are left to settle their differences as best they can.

A very similar affair took place in the department of Lot et Garonne. The Maire of Villeneuve-sur-Lot had authorised one M. Rault-Jay to fit up aerial leads for the supply of current. The local gas company grew sulphurous, and the Maire used his power in their favour. The same decrees and appeals as in the case of M. Colette, until on August 3rd, 1893, the Court of Cassation annulled the decrees against M. Rault-Jay.

As regards the suit brought by the gas company against the town, the inhabitants would doubtless find that a judicious "boycott" would be their best weapon.

CORLISS COMPOUND ENGINES FOR ELECTRIC LIGHT WORK.*

By E. L. DEBELL.

Without attempting comparisons with any other types I will endeavour to give the conclusions arrived at from the use of Corliss engines in our plant at Sheboygan, leaving each of you who is interested to compare them with results or knowledge obtained of the other types. In our plant we have been running steadily for the past 15 months a Corliss cross-compound, 24 by 28 high pressure cylinder, 46-inch diameter low pressure, speed 74 revolutions per minute, rated capacity about 650 H.P.

We use a syphon condenser, supplied by a duplex pump with two 18-inch steam, and two 12-inch water cylinders, 12-inch stroke.

We carry constantly 25 inches of vacuum, which, however, can be readily increased to 28 inches should the load be very heavy. When the load is light we consider it the best practice to keep it at 25 inches and reduce the steam pressure.

A good Corliss engine of this size and type should handle its rated economical load on 18 lbs. of water evaporated per horse-power hour and within a range of 20 per cent. above or below that point on not over half-a-pound additional. With good boilers properly fired, and allowing 7½ lbs. of water evaporated per pound of coal, this would equal 2·4 lbs. of coal per horse-power hour.

It should be borne in mind at this point that while the first cost is higher for an engine capable of running the least coal, it is really cheaper in the end, as less investment is required for boilers, and the saving in coal continues for all time.

The first cost of the Corliss engine may be placed at one-third more than an equally well made one of the high speed

* Abstract of a paper read before the North-Western Electrical Association, January 17th, 1894.

type, and it takes up about one-third more room. Its life, however, is generally conceded to be 50 per cent. longer, on account of larger wearing surfaces and slow speed. The greater bulk is usually of no serious moment, except where space is restricted or valuable. The cost of attendance and oil and waste is practically the same as on any other good engine, while the cost and facility of making repairs seems to be in their favour.

Another feature of the Corliss engine is that trouble usually develops slowly, in most cases giving warning of its existence in time to apply the proper remedy before it becomes serious, sometimes saving a shut-down of more or less duration.

The selection of proper sizes is a very important consideration, as the addition of an extra cylinder reduces the range of economy. The load in nearly every electric light plant is so variable that one engine cannot do the work properly, and it is probable that in most cases three engines of one size will give the best results. They should be large enough so that one will handle the light load, two of them the heavy load, leaving one always in reserve. This gives an economical size for all the varying loads, and practically duplicates the plant with a minimum expenditure in idle machinery. The cost of the three engines will not be very much greater than the same capacity in one or two engines, and some less boiler capacity will be required.

As to close regulation and steady motion, no trouble should be had on this score, if the power machinery is properly installed and managed, and the engines worked within their economical range.

The proper appliances should be used both in the engine and boiler rooms to ascertain if the benefits paid for are being secured, and, if not, where the leak is. If more fuel is being consumed than seems necessary, examine the engines, and if they are working properly ascertain how much coal the boilers are consuming per pound of water evaporated. The trouble will most likely be found in one of these quarters, and when remedied good results will surely follow.

RULES AND REGULATIONS FOR ELECTRIC LIGHTING STEAMSHIPS.

By RANKIN KENNEDY.

III.

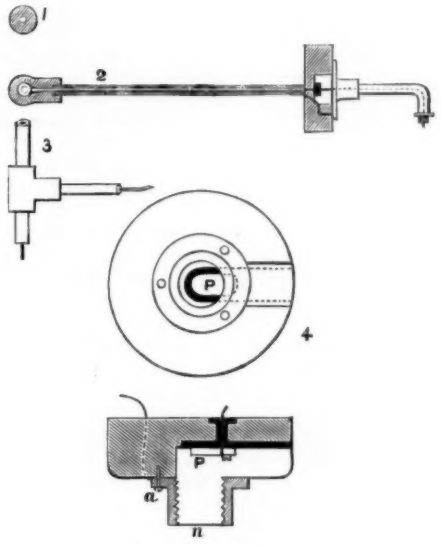
With any kind of fitting which can be fixed or moved without jointing, backblocks are requisite. These are usually made of hard wood, and are fitted with a contact spring, and sometimes also contain the fuse. Fig. 4 is a simple illustration of a backblock for single wiring. It has a brass nipple screwed to take the fitting. This nipple makes contact with the return wire, which terminates at *a*; the wire terminates at *p*, in a metal plate. On this metal plate is fixed a spring, somewhat like a bell-push spring, against which the centre pin of the fitting makes good contact. If double contact fittings are used, they must be fixed by a bayonet joint, or by a coupling screw to the backblock nipple, as they cannot be turned round or screwed into their place like centre contact fittings. To provide for high insulation, the plate, *p*, and the leading-in wire are insulated by porcelain or hard rubber from the wood block, backblocks of cast iron are also used for ship lighting.

Fuses and switches.—Nearly every light in a ship requires a separate switch. The saloons may have groups of lamps controlled by one switch. In that case each fitting should have a fuse in its circuit; but in all cases where a switch is fitted for each light, it would be better to have the switch and fuse in one cover. There is, I know, some unaccountable prejudice against such a practice, but just exactly why it should not be the rule has never been clearly explained. Of course, in most of the single light switches in the market, there is no room for a proper fuse; but there is no reason why a switch and fuse may not be made perfectly satisfactory in one, and thereby save an additional break in the wires and a separate fitting for a separate fuse. Every additional break is a source of danger, and so is every added little fitting.

What is a good or bad switch is well known, and requires little comment. The small single light switches with fuse combined are not usually of good design; but they must be cheap, because the cost of a switch and fuse is a large proportion of the cost of one light. It should be altogether non-inflammable, have quick-break, be waterproof, and have a good rubbing contact. The author prefers a good form of tumler switch, with a fuse fixed on raised wall on the china base.

Large switches for controlling sections of the installation are easily obtained of many excellent patterns, with separate fuses. In the case of these the cost is not of much account, as the cost of one switch is spread over 20, 30, or 40 lights; like the small switches they must be altogether non-inflammable, waterproof, quick-break, good rubbing contact.

Fuses should be prepared on a carrier; fuses made for 1, 2, 5, 10 ampères, and so on, and they should be of such a construction that it is impossible to put a 5 ampère fuse into a 1-ampère cut-out or a 10-ampère into a 3; the nut and screw cut-out with a short piece of tin wire ought not to be allowed on board a ship. The wire is coiled round once or twice under each nut or screw, and then caught by screwing up the nut or screw; in doing this the wire is often damaged, and fuses at too small a current. The attendant naturally puts in a thicker wire, or doubles the fuse wire to keep his lights going, and thus a fuse becomes of no use.



Figs. 1, 2, 3, and 4.

There are many good designs of fuses which would meet the requirements; they take the fuse between spring contacts, and the fuse is carried fixed on a plate or rod, and a 1-ampère cut-out will not admit a 5-ampère fuse.

Fuses only protect against short-circuits; they don't, and never can, protect against the two most common causes of fire by electric current on board a ship: first, corrosion of the wires by sea water penetrating the insulation, and, second, heating and arcing at unsoldered or bad joints. No appliance has yet been devised to protect against these defects or even to detect or indicate their presence. They can only be provided against by trustworthy supervision during installation, and by the choice of a system of wiring in which the chances of their occurrence are a minimum, and by reducing breaks in the insulation and joints of any kind to the smallest number possible.

It is of no avail to fix a minimum insulation resistance for an installation; that may be easily provided in an installation chock full of faults of the most serious kind. All the faulty joints shown in Electrical Review, February 23rd, might all of them have been in one installation, without reducing the insulation resistance in the slightest degree. Perfect insulation is a good thing, and must be insisted upon; but perfect conductivity is a much more important thing, and yet the fire office and other rules neglect it, while setting up insulation of the highest value.

Bad insulation can be provided against by fuses and cut-

outs; it is to protect against failure of insulation that they are used, but nothing is put in to protect against failure of conductivity.

The author once removed a piece of $\frac{7}{16}$'s insulated wire from a wood casing on a ship. This casing ran along through the stokehole, and hot brine had access to it. For 9 inches of its length five of the wires were entirely eaten away, and the other two were thinned; only two causes prevented a fire in this case. The wood case was thoroughly saturated with salt water, and some of the lamps on the circuit had been removed.

In deciding which is the best system to adopt, we must hold of first importance the making of good joints and the preservation of conductivity. The system which provides for these in the most effective manner is the best system, not the system which provides for high insulation only. It must be clearly understood that high insulation and a full complement of fuses of the best kind, don't always mean safety from fire.

Insulation.—Whatever system is adopted, the wires must be insulated on one side of the mains at least. What this insulation should consist of is a difficult question to answer without controversy. With a good mechanical protector, such as galvanised iron sheathing, or other armour, vulcanised rubber and jute with strong braiding, seems to meet the case.

With lead-covered wires, if every joint is made and can be maintained watertight, then the rubber may be dispensed with.

Many rules go upon the supposition that a joint in an insulated wire can be re-insulated, and be made perfectly watertight, and be for all time as good as the uncut insulation. In practice, such joints are never perfectly re-insulated, the materials themselves are not perfect — rubber strip and solution, prepared tapes and Chatterton's compound—and are seldom applied with skill. Messrs. Glover & Co. supply a portable vulcaniser for joints, whereby joints, after being insulated with rubber, may be thoroughly vulcanised and made equal to the rest of the cable.

In every case where the joints insulated by wiremen on a ship are to be taken as thoroughly durable and perfectly watertight, without a waterproof protector, vulcanising should be insisted on.

But it is, perhaps, safer and better, on the whole, to suppose every joint insulated by wiremen on board a ship as not waterproof, and very much inferior to the original insulation, and, therefore, provide a cover or box, or junction, which can be relied upon as being watertight; that is to say, if we cannot make the insulation applied by wiremen watertight we must make the protector watertight.

As joints are the great difficulties to deal with, the fewer they are the better; hence, one great advantage of single-wiring compared with double-wiring. We can do with just one-half of the joints requiring thorough insulation.

The single-wire system, as advocated by the author, is really a two-wire system with the central wire thoroughly insulated and concentric with the outer wire, which may be partially or wholly insulated from the ship or not. No return wire is attached to the ship; all returns go back to the outer wire (see figs. 1, 2, 3). Fig. 3 shows coupling for a branch.

ELECTRICITY AS A MOTIVE POWER IN FACTORIES.

Decentralisation may have some undoubted advantages when applied in certain directions to active politics and the problems of State Government; but, as a rule, it is not by any means a perfect success in the steam engineering plans of works and factories. In the development of large works the usual course has been for the management to erect a steam boiler and engine of just sufficient capacity to cope with the maximum demands of the machinery employed at the time, heavy belts and countershafting, with perhaps even bevel or other toothed gears being installed for the operation of tools and appliances in adjacent shops. The limit of losses by friction, inconvenience, and outlay is, however, soon reached when further extensions become necessary; and the consequence is, in such cases, that another set of steam generating plant has to be erected, in a suitable place, to form a fresh centre of energy supply.

It is not difficult to calculate the expense not only in first cost, but also in maintenance, involved by such a system. Instead of employing one large equipment of carefully tended and economical boilers and engines, there are scattered throughout the works several smaller and therefore more wasteful units, the gross capital outlay upon which is, as a rule, much in excess of that required for the larger plant. The working expenses will similarly be found to increase proportionally to the number of supply sources, each engine and boiler station requiring separate attendants, and separate fuel stores, upon which, of course, they draw far more than would be the case with a single plant having an output equal to the sum of the smaller ones.

Considerations of this kind are, it is pleasing to note, beginning to exercise much more weight with factory managers and proprietors in general than has hitherto been the case; and, of course, those most intimately concerned in the development of electrical work have led the way in effecting improvements of the kind, seeing that electric motive power offers the greatest advantages of any for cheap and efficient transmission and distribution of energy in workshops and factories.

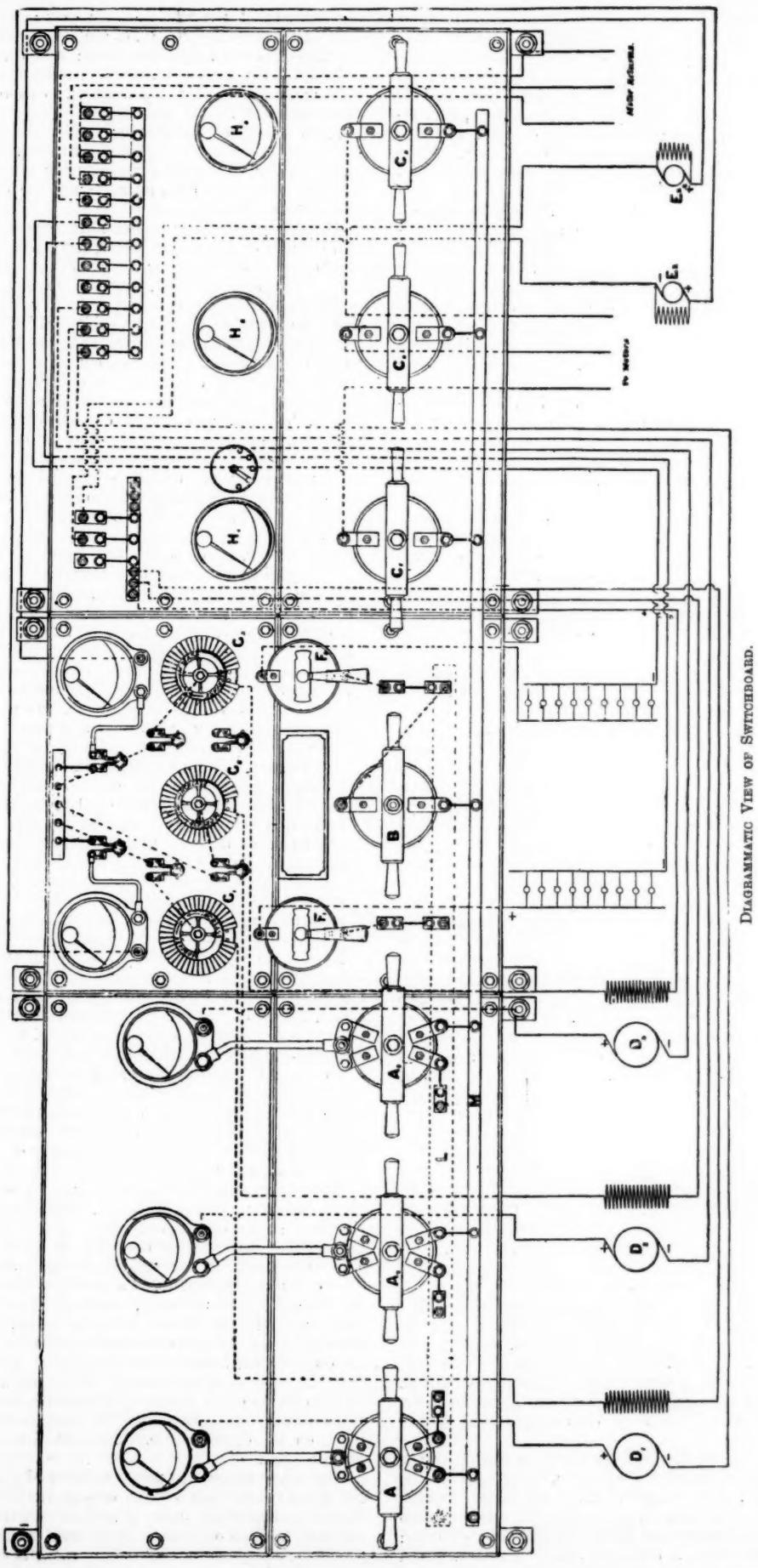
Many details have already been given, from time to time, in the technical journals of the electric motor installation at the Bushbury works of the Electric Construction Company, nearly all the tools being driven by separate small motors with current supplied from a large centrally placed steam and dynamo plant; a still more complete system is now at work in a small-arms factory at Herstal, in Belgium, and numerous other instances could be given in like manner to show the progress achieved both here and abroad. It will, however, be enough to present the details of one such system, especially as it is nearly the largest so far undertaken in this country.

The factories of Messrs. W. T. Henley's Telegraph Works Company, Limited, have long been known as of an extensive nature, owing to the varied interests carried on therein, and the character of the whole works may be taken as resembling very strongly—that which has already been sketched as typical of growth and gradual extension. Instead of one large central source of energy supply, the steam plants have been many in number, and scattered in locality, and it was to remedy this defect that the system now to be described has been carried out.

Messrs. Henley's works lie between the river Thames and the Great Eastern Railway at North Woolwich, with a street separating them into two halves. The generating station, which has been erected for the supply of electric energy to drive motors all over the works, is situated in the part between the railway and the street, so that it can hardly be called "central"; but, of course, the total area covered by the works is not so great as to make any material difference, although the distribution is on the ordinary two-wire parallel system, and at a low pressure, viz., 110 volts.

New buildings have been specially erected for the generating plant, the engine room being especially fine and well lighted. It is also designed to allow for extensions in the future, there being accommodation for double the plant at present installed. Similarly, the boiler house, containing, at present, only one large boiler, can be very easily enlarged for the addition of three others when the whole plan is carried out at an early date. Arrangements will then be made for an elevator by which the fuel may be conveyed from the railway trucks (which are run into the works by means of a private siding) to a suitable store, and thence distributed by a worm conveyor into the mechanical stoker hoppers.

The boiler used in the power house has been specially made for the work by Messrs. Daniel Adamson & Company, Dukinfield; it is of the Lancashire type, 30 feet long and 8 feet diameter, each flue being 3 feet 3 inches diameter. The ordinary working pressure is 120 lbs. per square inch. The boiler has been tested to 240 lbs. hydraulic pressure per square inch, and complies in all respects with the Board of Trade rules. The shell plates are butt-jointed in the longitudinal seams with inside and outside strips and four rows of rivets. Circular seams are double-riveted. The mechanical stoker is by St. Clair, of Manchester, and is driven with belting by a small donkey engine fixed on a bracket shelf attached to the boiler-house wall. The same engine also serves to



Diagrammatic View of Switchboard.

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rock the furnace bars to and fro, in order to secure open air ways and avoid clinkers. The boiler feed is given by a small horizontal Tangye pump of similar pattern to the Worthington type usually employed for the purpose; the feed-water passes upwards through a vertical Babcock feed-water heater erected in the adjacent engine room, and inserted in the exhaust steam pipe from the engines, a by-pass allowing it to be cut out altogether when necessary. From the boiler flues the smoke and gases of combustion pass into the base of a circular brick chimney 100 feet high.

Steam is conveyed from the boiler, through the wall separating it from the engine room, to a large inverted compound vertical engine made by Messrs. G. E. Belliss and Company. This is one of a pair which will form the complete steam plant, the second engine and additional boilers being added as quickly as the shops can be got ready and rearranged for motor driving.

Each engine will be capable of developing 230 I.H.P with an entering steam pressure of 120 lbs. per square inch, and a speed of 230 revolutions per minute. The high pressure cylinder is 14½ inches diameter, and the low, 24 inches diameter, the stroke being 14 inches, and cranks set at right angles. A piston valve is employed for the high pressure cylinder, with automatic cut off actuated by a centrifugal governor on the crank shaft, the speed being controlled within 5 per cent. whether at full load or running light. An auxiliary steam valve—acting as a by-pass to the main steam valve—admits steam direct to the low pressure cylinder when starting, and a ratchet lever arrangement on the fly-wheel is also available for barring round the engine.

The Belliss engine has achieved quite a reputation in electrical work for easy and economical running at the high speeds required for driving dynamos direct: and the makers claim that no small part of this creditable result is due to the special system of lubrication employed on these engines. As will doubtless be remembered, a small oil pump is worked from the crank shaft and circulates a stream of oil through all the bearings and bearing parts. In the Willans engine, the plan adopted is almost that of running the engine in a bath of oil; Messrs. Belliss, however, seem to aim rather at confining the oil as much as possible to the working parts, lubricating them from the interior instead of the outside.

A short length of extension shafting, 5 inches diameter, is coupled to one end of each crank shaft, outside the engine frame, and runs in two massive bearings upon cast-iron pedestals bolted to concrete foundations. The available space on the countershaft affords room for several wrought-iron pulleys or drums, 80 inches diameter and 12 inches on face, the rims being perforated so as to give a better hold to the belts by avoiding air films and consequent slip. Belt races are cut out of the concrete floor, of sufficient width to accommodate four belts, each of which drives a generator, so that there are eight of the latter in all.

Each dynamo generator has a capacity of 375 ampères at 115 volts pressure, and a speed of 600 revolutions; they are of Crompton's make, bipolar type, with drum armatures and vertical magnets. At full load the current density does not exceed 1,750 ampères per square inch in the armature conductors. These machines are separately excited, two smaller shunt wound dynamo generators, also made by Crompton and Company, being fixed close alongside, and driven by belts from the extension shaft. They have each an output of 70 ampères at 150 volts pressure, and a speed of 950 revolutions per minute; and either of them is fully able to excite the four generators, so that one acts as a reserve, or may, if required, serve to charge an accumulator for small currents at night time, or other periods of light load.

Current from the generators passes to a large main switchboard erected on the side of the engine-room wall, and made by Messrs. J. G. Statter & Company, Limited, from the designs of Messrs. Kincaid, Waller and Manville, who have acted throughout as consulting engineers for this installation.

The annexed illustration in diagrammatic form represents very clearly the arrangements of circuits governed by the switchboard.

From this it will be seen that there are two main omnibus bars for the positive leads, one marked L being used for the lighting circuits; and the other, M, for the motor circuits. By means of the switches, A_1, A_2, A_3, the respective dynamo generators may be coupled to either of the omnibus bars; and through the switch, B, the latter are, if necessary, joined together so that the whole system may be run in parallel. The switches marked C_1, C_2, C_3 are for the motor circuits; F_1, F_2 control the lighting circuits; and G_1, G_2, G_3 regulate the current (by means of graduated resistances) through the field magnet coils of the generators, so as to preserve the voltage constant.

At H_1 is fixed a voltmeter for reading the potential of the respective generators by means of a five-way switch. H_2 and H_3 are similar voltmeters for measuring the voltage of the lighting and motor bars. D_1, D_2, D_3 are the three generators at present employed.

This arrangement of switchboard appears to have been well thought out by the engineers, and much credit is further due to Messrs. J. G. Statter & Co., Limited, by whom it was constructed and supplied, for the careful and excellent workmanship which it manifests.

From the main switchboard, cables are led to the different shops where motors are employed. At present there are only 10 of these at work, ranging in output from 2 to 15 brake H.P., but others will be added as quickly as possible when the shops are re-arranged, in some cases re-built, the separate boilers, engines, and heavy countershafting being then abolished. Amongst the departments now operated by motors may be mentioned first the gutta-percha and India-rubber spreading shops which occupy the ground floor of a fine new block of buildings close to the railway.

The India-rubber spreading shop contains several machines for rolling and covering lengths of linen with numerous coats of pure rubber, all of which are driven by belting from a light countershaft rotated by a Crompton motor, taking at full load 69 ampères at 110 volts, with a speed of 800 revolutions. The gutta-percha shop close alongside is provided with three motors, two of which are fixed on the floor of the examining room above, driving the machines (with long water troughs the whole length of the building) by means of belts, the floor boards being cut away for belt races. These machines are of Elwell-Parker make, and each requires 50 ampères current when fully loaded at a pressure of 110 volts, and a speed of 1,000 revolutions.

The third motor is mounted on a hanging platform with iron frame bolted to the steel girders so as to be out of the road, a clear headway of some 10 or 12 feet being left between the base of platform and ground floor level. This machine is able to give out nearly 10 H.P. at a speed of 800 revolutions, and is also of Crompton's & Co.'s make. It is used to drive by belting a couple of gutta-percha masticators or warmers. Room is left on the hanging platform so that another motor may be installed, of similar output, for driving additional masticators when required.

At the far end of this shop is a refrigerating appliance, comprising an ether pump and circulating pipes for cooling the gutta-percha. This was formerly worked direct by steam, the two cylinders being placed tandem fashion; by taking out the steam cylinder, however, and throwing the pump forward on the baseplate, space has been obtained for a 15 H.P. Crompton motor. Of course, speed-reducing gear becomes necessary, the motor driving by belt on to a drum (with perforated rim) keyed to a second motion shaft. Double helical gear is then used to transmit the motion to the pump-crank shaft, the total reduction of speed being in the ratio of 10 to 1.

Above the gutta-percha covering shop is the examining room, where two Statter 2-H.P. series-wound motors are employed; one of them drives a short length of light countershaft for working the reels or wooden drums upon which the wires when covered are wrapped after inspection. The other is mounted upon a platform hanging from the roof at one end of the room, where it drives by belt on to a second motion shaft carrying a friction pulley. Placed in line with the latter is the fly-wheel of a small overhead travelling crab winch, also mounted on the platform; the winch axle has a slight movement in one of its bearings, being pivoted on the other, so that it may by means of a lever and rope be thrown into contact with either the friction pulley or a brake block on the opposite side. The motor runs continually in one direction.

The same motor also serves to drive—by an extension of the countershaft—a jib crane outside the building, exactly similar arrangements being provided for lifting and lowering from a winch on a hanging platform in the next room, to which the crane chain is led. This room is used as a light

braiding shop, and contains at present two long rows of braiding machines, with space for at least one more row, the whole being worked by small countershafting and belts from a 9 H.P. Crompton motor, taking 69 ampères at 110 volts, and 800 revolutions.

Passing back to the older portions of the premises, the lead covering department may be hastily noticed; the hydraulic pumps for operating the lead presses are to be worked by means of a Crompton motor of 15 H.P. output, taking 116 ampères at 110 volts and 800 revolutions. Then there is close by the compounding and winding shop; here it is proposed to re-arrange the troughs and general plan of working, in order to employ a motor for driving the wire reels or drums.

In the other part of the works, towards the river, lie the stranding and India-rubber covering shops. Each of these contains a number of heavy machines which were formerly driven by heavy countershafts, 3 inches, 4 inches, and 4½ inches diameter, worked from separate steam engines. Now, however, it is found possible to employ light shafting of diameters from 2 inches and 2¼ inches up to 3 inches, driven from two 15 H.P. Crompton motors, one for each shop. The economy thus effected by reducing friction, &c., may be readily imagined.

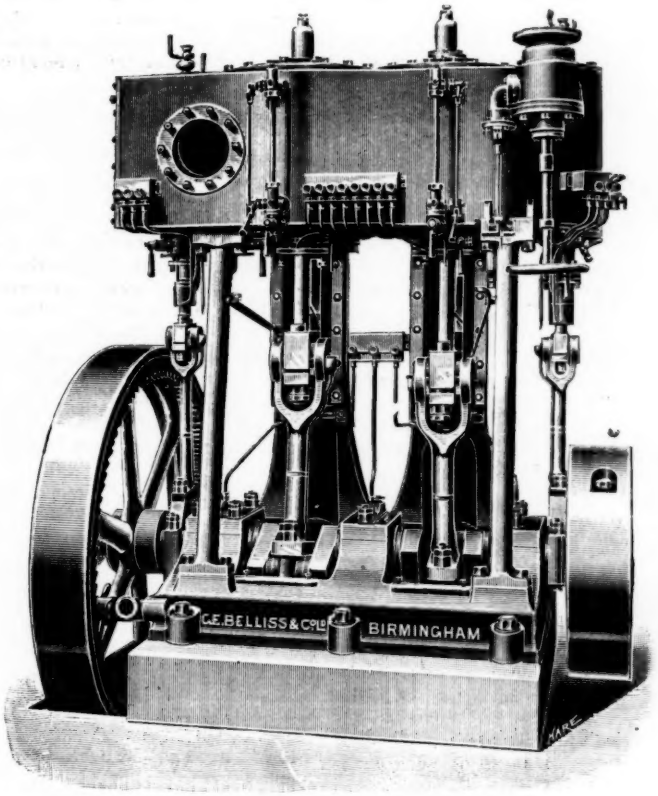
One of the steam motors, a large compound horizontal engine, has been retained to work the heaviest of the stranding machines, and a short length of the old countershafting is also left ready for belting up to the engine on the one hand, and the new line of shaft on the other, in case of emergency; but this plan, of course, will not be permanent. As soon as possible, a separate motor will be installed to drive the big stranding machines.

Besides the fixed motors thus enumerated, there is a small one by Statter & Co., which is used on board ships or on the works jetty for running cables in or out; this is made easily portable for moving from place to place.

For testing cables, such, for instance, as are employed on high tension alternating circuits, a Swinburne alternator with Gülcher exciter is used with a transformer, &c.

All the motors are provided with resistances in galvanised iron frames for switching in or out, and thereby preventing an overload or rush of current, with consequent injury to insulation, &c.; and separate switch automatic cut-out and instrument boards have been erected for better regulating and watching their performance.

Taken as a whole, this installation of electric power plant, though, perhaps, not actually the largest at work, offers many points of interest not only to the outside engineer, but also to those who make it their profession to study and practice the applications of electric energy in every direction; and a close view of the entire installation will not fail to excite in such a keen appreciation of its good points, with a consequent wish for success in all points to follow the efforts that have prompted the change.



Belliss's Inverted Compound Vertical Engine.

THERYC-OBLASSER SECONDARY BATTERY.

This cell has been submitted to tests by Dr. Fleming, and an extract from his report has been published which might impress the uninitiated to the effect that this cell shows a distinct and considerable improvement if compared with existing types. We must give Dr. Fleming credit for the reserve with which he qualifies certain assertions, but even with this, we think that the tests referred to are far too few and too short to allow of any final conclusion being drawn from their results. As appears from the report, the cells were received at University College, London, on December 16th, 1893, while the report is dated February 6th, 1894. Even if the cells had been submitted to regular charges and discharges during this space of time—which we do not assume to be the case—the time would have been too short to decide the most important and vital question, viz., the question of durability.

The conclusion arrived at by Dr. Fleming that the battery, with regard to capacity, is in advance of what has been achieved before is not founded on facts. Batteries of a much higher capacity per lb. of plate have been made and are being made for special purposes, but the experience gained during the last 15 years has proved that it is not considered

advisable to manufacture batteries of such high capacity if considerations for the securing of regular working and reasonable lifetime prevail. We know that batteries on an improved Planté type are being made of a capacity not inferior to that of the Theryc-Oblasser cells. It is, therefore, at least premature to assert that this battery is an advance on what has been achieved before, but in our opinion this is far from the mark: what remains to be proved is the lifetime of the plates.

When comparing this type with a Planté type it is hardly fair to take for a representative of the latter the Crompton-Howell plate, for although no paste is used in their manufacture it must be borne in mind that they do not represent the Planté type, by reason of their consisting of a conglomerate of small lead crystals with minute interstices between, as distinct from a metallic plate without such intervening spaces. If a plate of the latter type is taken for comparison, it will be found that the ampère-hour capacity is much higher. It is quite impossible to draw from a few tests conclusions as to the superiority, or otherwise, of one type over another. Dr. Fleming is candid enough to confess "nothing but very extended experience will determine this." If the cell has not as long a life as existing and established types, its higher capacity, if any, is of little avail.

There occurs the following in the report which we will repeat here in order to make our comments better understood. Dr. Fleming says: "After two discharges to form the plates, the cell was discharged beginning at 10 ampères, the mean rate of discharge being 7 ampères, or 19·7 ampères per square foot. The ampère-hours of the discharge were 33·8 and the watt-hours 44·1; hence, at the third charge and discharge, the ampère-hour efficiency of the cell was 93·5 per cent."

It is possible that whoever is responsible for the extract went too far in his endeavour to eliminate matter which he may have considered superfluous, for the meaning of the paragraph as it stands can only vaguely be guessed at. The ampère-hours and watt-hours of the discharge are given, but as the corresponding figures relating to the charge do not appear, it is impossible to see therefrom how the ampère-hour efficiency of the cell is arrived at. A still more serious omission is the absence of the figure relating to the efficiency in watt-hours. Without additional information, which we hope will be forthcoming, it appears that, comparing the discharge in ampère-hours and watt-hours, the cell must have been discharged down to 1·3 volts, a fall of potential which is hardly permissible in practice, and which makes it all the more desirable that the efficiency in watt-hours should be given.

The test further referred to of discharging 5 or 6 times more in order to observe if the high rate of discharge had any deteriorating effect upon the plates will be considered by experts as of not the least value. In order to determine whether such an effect takes place, the tests should have been extended over at least three months uninterruptedly.

Turning now to the "conclusions" drawn from the report:—

1 and 2. We meet with the statement that the Theryc-Oblasser plates have a higher capacity than any other existing practical secondary plate with which Dr. Fleming is acquainted. In this form no objection can be taken to the remark, but, as a matter of fact, secondary batteries do exist with as high a capacity, although Dr. Fleming may not be acquainted with them.

3. The statement that for lower rates of discharge per square foot, the capacity could, no doubt, be made greater than 7·5 lbs. of positive plate, is of little practical value, for, as will be seen from the table contained in the report, the capacity at as slow a discharge as 20·9 hours was only 7·46 ampères per lb. of plates.

4. It can be shown that the assumption that this capacity is about double that which we were accustomed to find in existing practical forms of secondary batteries is contrary to facts.

5. It is utterly useless when speaking of a secondary battery to say what they "appear" to be capable of giving.

6. The use of an envelope with the object of preserving the plates from buckling or short-circuiting has been repeatedly applied. There are a great number of patents bearing upon the subject, amongst others we will only mention the Tomassi accumulators, with regard to which very high expectations were raised and for which even a higher capacity than that shown by the Theryc-Oblasser battery was claimed. However, none of these batteries using envelopes for the purpose described seemed to have met with any practical success. Again, although the internal resistance of a battery may be reduced by placing the plates near together, yet the fact must not be lost sight of, that another and more serious source of resistance exists in the plate itself, and, judging from past experience, we are led to believe that a plate in which the active material is packed round the conductor will develop, after some time, a comparatively high internal resistance.

7. The power of this plate in permitting heavy discharges is nothing extraordinary, such property being shown in a much more marked degree by improved Planté types, but it is in our opinion premature to speak of the absence of apparent injury without more prolonged and more severe tests. Extended experience with several types of pasted plates have shown that the jolting of a tramcar, together with the heavy discharge rates to which the cells are, of necessity, submitted, have a most deleterious effect, loosening the contact between the active material and the conductor and greatly disintegrating the former; and it has further been found that the perforated envelopes offer no remedy for the loss of material, which finds its way gradually through the holes. Even the few charges and discharges made by Dr. Fleming have sufficed to produce a certain amount of disintegrated material in the form of mud in the bottom of the cell.

8, 9. To establish the fact that local action is greatly diminished by the lead supporting grid being buried would necessitate proper tests being made. For the sake of comparison we may here mention that a cell of a well-known type, which we tested ourselves, after remaining idle for about three months, showed at the first discharge a capacity of 80 per cent. of the normal. It would be interesting to learn the corresponding figures with a Theryc-Oblasser battery.

10. That the closed envelope is no preventative against the material being knocked out has been proved in many instances before.

Summing up:—It does not appear to us, and we cannot grant, without further convincing proof, that the Theryc-Oblasser battery marks any step in advance as compared with some existing and well-established types. Electricians and users have agreed for some considerable time that the best type of battery in existence is based on the Planté process, and the use of paste, whether compressed or not, must be considered a retrograde step. With such batteries it has invariably been found that the contact between the active material and the support becomes more and more imperfect, and this is easily explained by the fact that any interstices between the two, however small, offer fair bases of attack by the sulphuric acid, converting the adjoining parts into sulphate, which, by reason of its increased bulk as compared with the original active material, tends still further to accelerate that process. In addition thereto, the active material gradually disintegrating and dropping out through the holes of the envelope, the material is no longer closely packed but more or less loose, making only very imperfect contact with the conductor in the middle, so that the result is a speedy deterioration and final destruction of such plates.

There is no feature in the Theryc-Oblasser battery distinguishing it from such accumulators, which, although possessing a fair storage capacity when new, yet cannot be made a commercial success by reason of their inherent defects.

We attach Dr. Fleming's report on the battery.

REPORT ON THE THERYC-OBLASSER SECONDARY BATTERY.

On December 16th, 1893, I received at University College, London, at the electrical laboratories, a 2-cell Theryc-Oblasser secondary, with a request to report on the same. As far as it is possible to do in the short space of time which has since elapsed, I have examined the behaviour both of this battery and of a smaller one made on a like principle. The first battery of 2 cells contained in each cell 11 plates, viz., 5 positive and 6 negative. I also examined at a later date a single cell of the same construction containing 3 plates, viz., 1 positive and 2 negative.

The following table shows the result of discharge at 10, 20, 40 and 80 ampères with the 11-plate battery:—

Rate of discharge in ampères.	Capacity per lb. of plates in ampère hours.	Current density of discharge.	Total charge got out in ampère hours.
10	7·46	3·59	209
20	7·14	8·9	200
40	6·44	17·8	180
80	4·82	32	135

The general conclusion to which I was led by the above experiments was that the battery, so far as I could judge without much more extensive experience of its durability, was an advance on what has been achieved before. The plates of this battery do not seem at all deteriorated by the heavy discharges I have given it.

High capacity in ampère-hours per lb. of plates is generally associated with rapid deterioration of plates under large discharges, and, broadly speaking, a great specific capacity in ampère-hours per lb of plates is usually associated with a low safe rate of discharge.

In battery plates of the "packed grid" type, such as the E.P.S. cells, the maximum rate of safe discharge prescribed in the trade circulars is generally fixed at 8 to 10 ampères per square foot of positive plate surface, and at this rate of discharge the ampère-hour capacity is about 3 ampère-hours per lb. of plates taking both together. A plate of the "Planté" type, in which the peroxide of lead is "formed" on the plate and not applied to it, will generally bear a higher safe rate of discharge than a plate of the "packed grid" type. Thus the maximum safe working discharge of a Crompton-Howell plate is stated in trade circulars to be about 20 ampères per square foot, and at this rate of discharge the ampère-hour capacity is certainly in practice not more than 3 ampère-hours per lb. of plates.

We have, however, found by the Theryc-Oblasser cell tested, an ampère-hour capacity of 6 ampère-hours per lb. of plates when discharged at the rate of 20 ampères per square foot of positive plate surface.

If the Theryc-Oblasser plate has therefore as good a life, or no better a life than the Crompton-Howell plate, it will be superior to it in specific capacity at the same rate of discharge. From what I have seen of the Theryc-Oblasser plate I should judge that it would be superior in life to either the "packed grid" plate or the "Planté" plate as usually made, but nothing but very extended experience will determine this; if it has no better life it will have a double capacity.

A 3-plate battery was at my request sent to me, consisting of one positive and two negative plates in one cell. The weight of these three plates together was 6·88 lbs., and that of two of them 4·5 lbs. The total exposed surface of the positive plate was 0·365 square foot. In reckoning capacity per lb. of plates, it is obviously fair in such a case to take the weight of one positive and one negative plate, because only the inside surfaces of the negative plates are used.

After two discharges to form the plates, the cell was discharged beginning at 10 ampères, the mean rate of discharge being 7 ampères, or 19·7 ampères per square foot. The ampère hours of the discharge were 33·8, and the watt-hours 44·1; hence, at the third charge and discharge, the ampère-hour efficiency of the cell was 93·5 per cent.

The result of the tests with this 3-plate cell confirm the conclusion derived from those of the tests with the 11-plate cell, that the ampère-hour capacity per lb. of the plates is about double that of the best plates of the "packed grid" or "Planté" types when discharged at the same rate per square foot.

In addition to the above tests, this 3-plate cell was charged and discharged at the 10 ampère rate for five or six times more, in order to observe if this rate of discharge of 30 ampères per square foot of positive surface had any deteriorating effect on the plates. At the end of these discharges the cell was emptied and examined. The plates seemed totally unaltered, and there was only a very insignificant amount of active material disintegrated in the form of mud on the bottom of the cell. There were no signs of breaking or cracking of the envelope or of the plate.

Conclusions.

As far as the very short time these cells have been under my observation, viz., about six weeks, will allow me to speak, I may say that the tests to which they have been submitted show the following facts to be true:—

1. The Theryc-Oblasser plate has at the same rate of discharge per square foot of active surface undoubtedly a higher capacity in ampère hours per lb. weight of plates than the other existing practical secondary plates with which I am acquainted.

2. The ampère hour capacity per lb. of plates has in these experiments been shown to be 7·5 when the discharge is at the mean rate of 20 ampères per square foot of positive surface.

3. For lower rates of discharge per square foot it could no doubt be made greater than 7·5 ampère hours per lb. of plates.

4. The above capacity is about double that which we are accustomed to find in existing practical forms of secondary battery, even when discharging at only 10 ampères per square foot.

5. The plates appear to be capable of giving discharges at the rate of 50 to 100 ampères or more per square foot of positive surface without damage, which seems to be two or more times as much as the safe maximum rate of discharge of existing forms of secondary battery plate.

6. The envelope in which the plates are contained preserves the plates from all "buckling," and from contact with one another, by which internal short-circuits can be produced. Hence the plates can be placed near together, and the internal resistance of the battery made very small.

7. The extraordinary power of this plate in permitting heavy discharges to be taken from it without apparent injury peculiarly fits it for use in tramway work, and there is good reason to beleive that in this respect the plate has no equal.

8. The fact that the lead supporting grid is entirely buried in the compressed active material greatly diminishes the rate of decay of charge by local action, and the samples of plates which have been shown to me, and stated to be plates which have been in use for some time, show little or no signs of disintegration of the grid.

9. As a consequence of this last the plate seems to hold its charge well for a very considerable time if the battery is kept without discharging.

10. The entirely closed non-conducting envelope in which the compressed active material is contained, prevents any chance of active material being rapidly knocked out of the plate by jolting, or by jolting vibration and heavy discharges combined.

11. Generally speaking I consider the chief virtues of this plate to be the following:—The compression of the active material into one homogeneous mass of high conductivity, which enables the whole of the plate to contribute current rapidly. The entire submergence or inclusion of the supporting grid or lead frame in the compact mass of active material, whereby the local action between the lead support and the active material is prevented. The inclusion of the whole mass in a non-conducting envelope of slightly expansible material perforated sufficiently to allow access of the current to the liquid, but not sufficiently to allow the active material to fall off the plate. The compression exerted by the envelope when the plate is charged, particularly the positive plate, exerts a beneficial effect in preserving the whole of the active material solid and free from cracks or fissures.

The grid being buried in the interior and wholly shielded from electrolytic action can be made very light: hence results a large ampère-hour capacity per pound of plate. The solidity and conductivity of the plate gives it a large safe maximum rate of discharge.

These points seem to me to be the novel and valuable features in the Theryc-Oblasser secondary battery plate, and give it in my opinion a position of advantage when compared with other well-known and used forms of secondary battery plates.

The Theryc-Oblasser Battery appears to me to be particularly adapted for electric traction work both by reason of the capacity of the plates, and also on account of the rapidity with which it is possible to charge the plates and discharge them without apparent injury to them. Unless further experience should reveal now unsuspected causes of deterioration in the plates, there is good reason to believe that the life of one of these plates will surpass that of present existing forms.

February 6th, 1894. J. A. Fleming.

CORRESPONDENCE.

Electric Lighting of Steamships.

I must apologise for taking up your valuable space with controversy, but I cannot allow Mr. Rankin Kennedy's remarks *re* steamship lighting, in your last issues, to pass without comment.

Firstly, with regard to the effect on the compasses, due to the two methods of wiring, *i.e.*, "double" and "single." Theoretically, there is no question as to which is most liable to effect the deflection, and I think that to most electrical engineers who do any ship lighting, practical experience leads to the same conclusion. I have not personally had an opportunity of making such a series of exact tests as your correspondent, Mr. Muitt, but in the results obtained in ships wired under my superintendence, I have come to the undoubted conclusion that with double wiring the leads may be run as desired, quite regardless to their position with regard to the compasses, and no appreciable error is caused to the latter; but with single wiring, even when carefully done and planned with due regard to the compasses, the effect is not only generally noticeable, but frequently so to such an extent that serious errors may result. After the series of tests made at Elswick, I do not think more need be said upon the subject, as "facts are better than words" in such cases.

The chief matter that I wish to take exception to in Mr. Kennedy's article is what he designates as the "primitive and barbarous" method of wiring fittings, or, in other words, of wiring the whole ship, as the fittings cannot be separated from the rest of the installation with regard to the system employed. I quite agree that ship lighting gives great scope for the jerry wirer, which has been fully taken advantage of, and things have now reached such a crisis that either Lloyds or the Board of Trade must soon take the matter up. Still, the way to meet the difficulty, and get rid of the jerry wirer,

is not to insist upon a complicated system (and one, moreover, that has no advantage over the other) which would always require an experienced man to remedy any slight fault that might occur during a voyage, which could with a straightforward installation be done by one of the engineers (the "second" has, as a rule, charge of the electrical plant, and often possesses a certain amount of electrical knowledge) of the boat in a perfectly satisfactory manner.

To follow Mr. Kennedy through his article. First the fire office rules are criticised with regard to the wires being kept 1½ inches apart, and then allowed to touch inside the fitting. I will not here enter into the question of the advisability or otherwise of double grooved wood casing, but would only suggest why is this system universally accepted on land installations, but condemned so strongly by Mr. Kennedy for ship work? The two ends are led to a lamp holder, ⅜ths or ¼-inch apart—is there more space than this between the contacts in the Andrews system? There are also holders on the market known as "bridge" holders, with a porcelain bridge between the terminals, which are largely used, and that overcome to a great extent this objection. As to the method of wiring fittings described, I must differ from Mr. Kennedy as to the *usual* way of doing this; the method generally followed (I am not speaking of the jerry wirers, whose ways of going about a job are sometimes wonderful in the extreme) is to put all the switches on one pole, and all the fuses on the other; a wire is led from the fuse and switch respectively through the bracket or pendant to the lamp-holder *without joint*; the fitting, I may remark, should never be *less* than ½-inch inside diameter, and should terminate in a ½-inch female thread, into which the lamp-holder is screwed by a ½-inch male thread. Mr. Kennedy refers to certain points where trouble always arises; these points are all present in the other systems of wiring described, and, moreover, under far more unfavourable conditions. As to the fittings, both the single and double wired are open to what is a great objection, viz., the pin connections; the points where faults are as likely as anywhere to occur are at the lamp-holders, with their more or less indifferent and bare connections, and yet in these fittings in question these points are multiplied, each fitting having three pairs of these contacts instead of one only.

Mr. Kennedy is careful to show two points where faults can occur, viz., switch and fuse; but are not these points also common to his system? Then, again, he urges as an objection to *wired* brackets, that the engineer in repairing it is liable to make a short-circuit; an engineer would, as a rule, I should *fancy*, switch the current off before starting to repair, otherwise I do not think an electrician, however expert, could re-wire the holder without a short; besides, in his system, Mr. Kennedy simply removes these points from the lamp-holder to the base of the bracket, where there would be just the same risk of a short as at the lamp-holder, should a repair be needed.

Taking the four systems as described. As to the cost, there is no doubt that the ship return (No. 4) is the cheapest by far to put up, and at the same time by far the most dangerous, owing, for one thing, to the number of more or less indifferent contacts made to the ship; the danger is lessened in the third system with a bare return lead, but it still leaves various other objections, action on compasses, double risk of breakdowns, &c.

As to the second system. It undoubtedly requires skill in fixing and makes a good job, *until any fault occurs*, and then the trouble begins; with two separate wires, they can be cut, jointed again, and insulated practically as good as they were before, but with concentric cables it is a very different matter, as anyone who has had them to joint will agree. Concentric wiring is undoubtedly a very valuable system for high potentials, as a safeguard to life, but with the 65 or 100 volts used on shipboard, this safeguard is quite unnecessary.

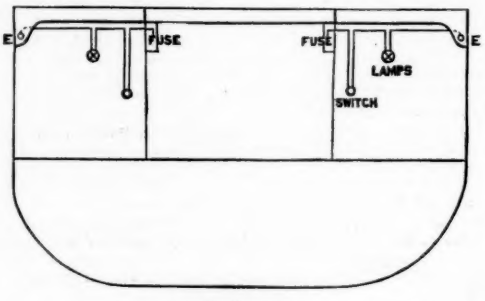
An ideal system of electric lighting, in Mr. Kennedy's opinion, seems to be a complicated one that nobody can fix except a man specially trained to it, whereas, in my opinion, an ideal system is one that *anybody* can fix, provided he can make a good joint and is careful to do what he is told, so long as there is an *experienced* man in charge to design the installation and to see that the design is properly carried out.

Jerry work, which is very common now, is due not to the system being bad, but to the erection and fitting of the system being bad, and the material used the cheapest and commonest obtainable.

E. George Tidd, A.M.I.C.E., A.I.E.E.

February 28th, 1894.

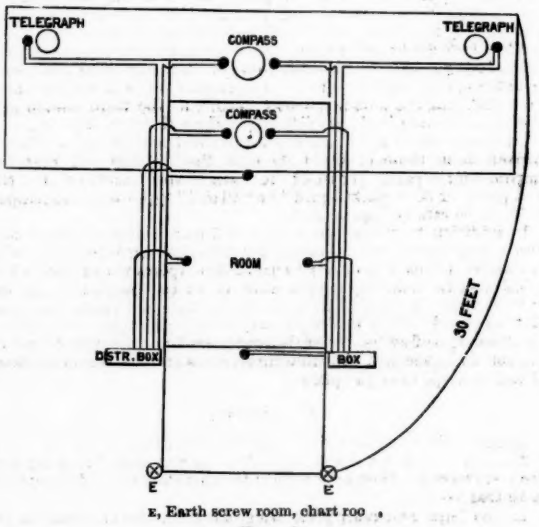
With reference to Mr. R. Kennedy's favour for the single-wire system and Mr. L. Muitt's dislike to it, regarding disturbances of ships' compasses, I should like to give a *via media* by saying that both systems are sound if carried out properly by a reliable firm of electrical engineers who employ conscious workmen. If a ship be wired on the single-wire system, connect your + terminal of dynamo to the ship side and lead with the — terminal, and there will be no corrosion at the earth screws. Bring the lead for each lamp from one side and the return from the other side of the ship,



E, Earth screw.

Fig. 1.

and make your earth with two brass washers and ⅜ brass screw, well cleaned earth wire between the two washers. All lamps on the same or deck below the compass must be wired on the *double-wire system* up to 30 feet away from it, and then you can safely connect the return to the ship's side.



E, Earth screw room, chart roo

Fig. 2.

Always fix two lamps to each compass, one on each side, and use *concentric* or twisted *twin-wire* for them, which have to be run on the deck below, on which the compass stands, and bring them up in brass or copper pipes outside the compass vertically. Equalise the number of lamps in said quarters, and run half on each side of the ship. I am pleased to see the illustrations of jerry joints you give in last week's edition, and hope that it may throw some light upon the subject of jointing. But list, ye landsmen; anno 1894, a new steamer left the Clyde fitted up with an electric light installation A 1 at Lloyds, of which only a few joints were soldered; all the others were not soldered, and covered with compo and black tape. This is no story, but a fact, and

should this meet the eye of the contractor for this installation, I should advise him to send a practical and experienced man to take charge of his work, and not a joiner, whose work is a disgrace to the Clyde, the largest shipbuilding centre in the world.

Leon H. Cline.

With reference to the effect upon the compass by the dynamo or mains, have any of your readers, in the course of their experience in ship lighting work, found it necessary, or know of vessels which are using two deviation cards to steer by, that is, one for the day time (dynamo not running) which all vessels have to use, and one at night time when the dynamo is running, the dynamo or cables producing an effect upon the compass which cannot be remedied?

In the case of the magnetic field of the dynamo causing the error on the compass which necessitates the removal of the dynamo to another part of the ship, and that is sometimes impossible owing to want of space, especially in old ships fitted with the electric light, where there is only one possible position in the engine room, unless it is placed outside, which for many reasons is unsatisfactory, the error produced on the compass when the dynamo is running at its normal voltage should be a constant factor, and by swinging the vessel its exact value at all points can be obtained; since for the lamps to be steady a constant voltage, and therefore a constant stray field must be maintained.

It is surprising that none of the previous writers have gone into this matter, as it is of frequent occurrence, but in most cases can be remedied by altering the position of the mains or dynamo.

It would be far more satisfactory to the contractors and clients, besides saving time, if some definite decision with regard to the relative position of the compass, dynamo, and cables were arrived at, and if an effect on the compass is produced whether the contractor is responsible for the same, provided nothing was mentioned at the time of signing the contract, and provided he has used all possible precautions to guard against the same; as if this is not the case, the contractor would be put to a great expense in the case of shifting the dynamo, making foundations, &c.

H. Boot.

Dublin, *March 6th*, 1894.

We have read your article on "Jerry Wiring in Steamships," and also the correspondence to which it has given rise, and would express our approbation at the stand you have taken.

But, as Mr. Walker so justly points out, it is not by any means in ship lighting alone that the jerry wirer is seen; unfortunately, his trail is to be found all over. Some firms appear to have started as electrical engineers (?) not with any idea of making a living profit, but either as a means to dissipate what money they may have, or, what is more probable, to live a little while by doing cheap and nasty work, then fail, and drift into something else—all this to the prejudice of the straightforward, honest firms who are anxious to do good work, but find it more profitable to close their works rather than to attempt to compete with the jerry wirers.

We have seen Mr. Walker's account of how men are engaged and paid by the jerry wirers. We will now put before you two quotations for different classes of work which we have seen:—

A.—A firm quoted £20 for supplying and fixing two 10-ampère arc lamps, and 20 16-C.P. glow lamps, with all necessary globes, shades, switches, brackets, casing, &c.

B.—Some time ago we were asked to quote for lighting a mill with 1,200 16-C.P. lamps—two dynamos, each of 42 kw. output, engines, and boilers and switchboard to be included, delivered and fixed. The specification was badly drawn up, but it was easy to see that what the millowners required was a first-class job. For good modern engines and boilers of the type required we were quoted by two or three of the leading firms £900 nett. Yet one electrical firm quoted £1,250 for the complete work. Needless to say, they did not secure the order; but the quotation was kept and shown as a curiosity—alas! a curiosity by no means rare.

As the lay mind will not study the principles of lighting, and to the majority a simple cut-out is something mysterious and of unknown quantity, what surprises us is, that people should still consider themselves competent to decide between rival tenders. Half-a-dozen firms are invited to quote for lighting a certain mill, each may have their own ideas, and the whole thing degenerates into a "go-as-you-please-race-the-lowest-tender-accepted" affair. Can you wonder that unscrupulous firms find this a golden opportunity? They quote for a minimum number of lights at a losing rate, and trust to make a profit on extras; even as we have seen, if they are forced to use D.C.C. wire in place of vulcanised cable.

Cannot mill owners and others be persuaded to put the whole matter into the hands of consulting electrical engineers; let them draw up the specification, and, above all, see that it is adhered to? When this is the rule, and not till then, will the death knell of the jerry wirer be sounded.

Rosling & Matthews.

Evidently from his letter in last issue, Mr. W. C. Martin is one of those alarmed at the prospect of the use of jerry wirers' materials being prohibited. It is to be expected that some contractors will object to the prohibition of such handy and cheap articles as those referred to. Mr. Martin's letter is not addressed to the subject of my articles, and is so biased, and somewhat personal, that I don't propose to follow him further than to say that his proposed inspections would be only a farce, if made under rules permitting the use of the materials approved of by Mr. Martin.

Rankin Kennedy.

You could devote your influence and space to no purpose more worthy than the crusade against jerry wiring for ships. That conscientious firms, who are familiar with the conditions under which ship wiring has to exist and the methods of providing for them, are being ousted from this sphere by the dishonest and ignorant cheap-jack, is a growing shame.

The shipowners and shipbuilders are much to blame in this matter; they too often invite tenders for the electric lighting of a ship, merely specifying the number of lights, and accept the cheapest offer. Contracts for shiplighting are frequently placed at a less sum than a reliable contractor would pay for the material. It is to be hoped that the agitation which you have succeeded in arousing will not subside until adequate steps have been taken by the Board of Trade to put an end to this inferior work, and the dangers arising therefrom.

After this, the primary question is settled, there will remain the minor one as to which of the methods in use for ship wiring, namely, double wiring lead-covered, double wiring in wood casing, single wiring, or concentric wiring, is the best. The writer has no doubt that single wiring is the worst; this also being the cheapest, has been generally adopted by the cheap-jack, with the result that the worst work is found on single wired ships. Good work (or, rather, the best possible work of its kind), is done in single wiring by several contractors of deservedly high reputation. Double wiring is much preferable to single wiring, and its greater safety and reliability are well purchased at the increased cost. The last, concentric wiring combines all the advantages, and avoids the disadvantages, of the others.

My emphatic contention is that no system of wiring which is not consistently and continuously protected throughout by a waterproof metallic sheathing is permanently durable and reliable under the conditions encountered on board ship. The British Admiralty recognised one half of this truth six or seven years ago, when they abandoned the use of wood casing and adopted lead-sheathed conductors. During the succeeding five years the constantly recurring troubles at the switches and fuses (the old patterns were still retained), due to the access of moisture, forced upon them the whole truth, and they then adopted waterproof switches, fuses, &c., in cast brass boxes. The difficulty of carrying out the watertight principle with double wiring will be realised by anyone who examines the present clumsy Admiralty patterns and endeavours to improve upon them. A comparison of these with

the compact and mechanical corresponding fittings used with concentric wiring is instructive. It is more easy to make fittings of reasonable size mechanically and electrically good in detail which have concentric contacts only, than those in which there are two contacts, each to be insulated from the other and both from the containing metallic casing. To the single wiring champion who says, "I have tried lead sheathing and find it does not last," the reply is, "Of course it does not, if you have your positive conductor sheathed with lead, and have a leak from the conductor to the lead covering, you may have the full E.M.F. between the lead and the ship's side, and will have the lead deposited away wherever there is moisture to assist the electrolysis."

To the double-wiring man who makes the same complaint, a similar reply is appropriate.

With regard to the question of fire risk to which you rightly direct special attention, single wiring is undoubtedly the most dangerous. It needs only a little damp woodwork between a conductor with damaged insulation and the iron work of the ship, and the proximity of some inflammable material to start a fire. Or in the case of double wiring, where the insulation is mechanically damaged or destroyed by varying conditions of temperature and moisture, the protective (?) casing may itself be the first to ignite and so cause fire. Accidents from such causes are within the knowledge of all who are called upon to make repairs on ship wiring. Single wiring or double wiring in wood casing, no matter how good the material and workmanship, CANNOT—my emphasis is warranted by experience—be made absolutely fireproof. Concentric wiring can be made and is made, absolutely fireproof, and also waterproof. The fittings having only one wire, lend themselves to mechanical treatment. There is no trouble from electrolysis, as the outer conductor is negative and at the same potential as the ship.

Double wiring advocates have much exaggerated the influence of single wiring upon ships' compasses. Mr. Kennedy has, in your current issue, well replied to Mr. Muitt's letter. Where ordinary precautions are taken in single wiring, the maximum disturbance to the compasses can be kept well within 1° (there are over 11° in one point). Special arrangements will reduce this figure. Double wiring gives a fancied security in this respect, which does not always exist. A fault in the insulation may lead to considerable compass disturbance. Concentric wiring with double insulation of branch conductors to lamps erected in the neighbourhood of compasses (in addition to the usual precautions) entirely avoids compass disturbance. I shall have much pleasure in giving any doubter, who is sufficiently interested to put the matter to test, an opportunity of attempting to disprove this statement.

Sam Mavor.

Glasgow, *March 6th*, 1894.

Balancing in a Three-Wire Station with only One Machine Running.

I am much obliged to Mr. Thursfield for his reply, and considering matters as they stand, think that something should be said in answer, bearing in mind that the simplest and most practical way of working was aimed at in the proposed arrangements.

Mr. Thursfield has, unfortunately, not given figures to go by, or it would have been evident that the objections which appear so fatal would not be found in practical working. The *difference between the lost volts* in the two windings of the generator armature is so small, that it may be wisely discarded in this particular instance (*i.e.*, the conditions described in the proposed arrangement), although the difference is as correctly remarked—the wrong way about. Further on, it is said that "shifting the position of the battery switches, shown at the bottom of the diagram, will produce no effect on the feeders, &c., &c.," which is to be regretted, as an examination of the diagram will show that any current which could possibly be passing up or down the balancing wire in a station of this size in everyday work could be easily dealt with in a battery of 62 cells on each side, by moving the discharging switches in the right direction, and the E.M.Fs. adjusted at the same time, remembering that it is only *half of the balancing current* which requires to be passed through the cells. And again, besides this means of balancing, there are the two-way switches for the station lamps, &c.

Using either or both of these means, the E.M.F. at the terminals of the two pairs of the generator brushes can be kept exactly equal, or, if necessary, slightly higher on the proper side, to compensate for potential drop in the balancing wire, plus the difference of potential drop between feeders.

Arthur H. Gibson.

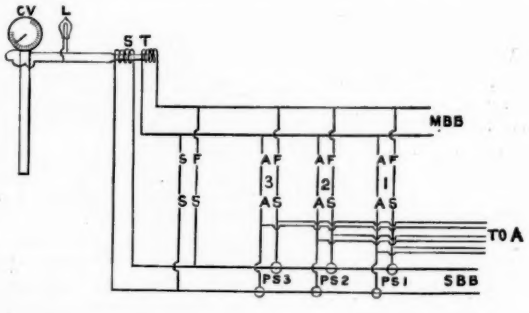
March 3rd.

Running Alternators in Parallel.

As there still appears to be a want of more general knowledge as to the facility with which alternators may be run in parallel, a few remarks as to such running at this station may be of interest to your readers, and serve to correct the erroneous impression that would be received from the remarks of "A Member" of the Northern Society of Electrical Engineers, as published in the report of their meeting.

Whenever more than one alternator is running on the mains at this station they, of necessity, run in parallel. During the past winter alternators have been put in parallel on an average nine times per week. There has never been any difficulty in running, and there is no danger of an accident due to large synchronising currents in switching in parallel in the ordinary way, if due care is taken; and if the method is adopted which I have in practice here, it renders an accident, due to carelessness or nervousness at the moment of switching in, impossible. The method adopted is as follows:—

If alternator No. 1 is running, on the mains, A, S, 1, being closed, and it is desired to put alternator No. 2 in parallel with it, the plug switches, P, S, 1, P, S, 3, must be out, the synchronising switch, S, S, be open. The synchronising fuses, S, F, must be of suitable size, that is to say, of such size that any quantity of current passing, that would be in any way injurious to either of the machines, or that would be liable to cause any noticeable variation in the voltage on the mains would cause the fuses to blow. Then start up alternator No. 2, and put in the plug switches, P, S, 2; the synchronising lamp, L, and the Cardew voltmeter, C, V, will then record the effective voltage given by the synchronising transformer, S, T. When the oscillation of the voltmeter needle is slow, showing that the machines are about their correct speed relatively, watch for an opportunity when the needle has nearly attained the maximum reading, and then close the switch, S, S. This will place the machines in parallel on the mains, through the small fuses, S, F. If the synchronise is unsuccessful these fuses will blow, and the operation must be repeated. With a fuse of 20 to 30 ampères, *i.e.*, three strands of 33 S.W.G. tinned copper, this need, however, never occur; but if all is well, close alternator 2, switch A, S, 2, and then open the synchronising switch, S, S, and the plug switches ready for the next occasion.



In this way I have put two 88 kw. Siemens-Willans alternators in parallel through a five (5) ampère fuse twice in three attempts without the fuse blowing. When using such a small fuse, however, it is necessary to run the in-coming alternator on the stop valve, as if it were run on the governor it will probably take a portion of the load as soon as the synchronising switch is closed, and then an excessively small fuse will give way.

If the governors are properly cleaned, the current passing between two alternators in parallel, either two of 88 kw., two of 210 kw., or one of 210 and one of 88 kw., as shown by the ammeters, does not exceed one (1) ampère, and often no movement of the ammeter needle can be detected.

Machines should be paralleled when the voltage given by the synchroniser is on the increase, *never when decreasing*, and preferably not when stationary.

The only inconvenience that has ever been experienced in putting machines in parallel at this station has been due to the time it may take to get the machines running in synchronism, should the load come on very suddenly, and the running machines be so much over-loaded as not to be able to keep speed. The risk of incurring this inconvenience will, however, I anticipate, be entirely overcome shortly.

H. Faraday Proctor,
City Electrical Engineer, Bristol.

Varley Testimonial Fund.

We beg to inform the readers of your paper that the accounts of the Varley Testimonial Fund must be closed on the 15th of the current month. We therefore make a last appeal to all those who have in one form or another benefited by the invention of the dynamo, compound coupling, and other matters with which Mr. Varley's name has been so largely associated, to send in a subscription to the undersigned before the above-mentioned date.

A. Stroh,
Hon. Treasurer.
R. E. Crompton,
Hon. Secretary.

[We sincerely trust that this last appeal will not be made in vain.—Eds. Elec. Rev.]

SOME RECENT STEAM ENGINE DESIGNS.

Mr. G. L. Clarke contributes some notes on this subject to *Cassier's Magazine*, but only one American engine is illustrated, of vertical cross-compound Corliss condensing type, by the Philadelphia Engineering Company, intended to develop 800 H.P. at 103 revolutions and 125 lbs. boiler pressure. The cylinders are 20 inches and 36 inches diameter respectively and the stroke 3 feet. The belt pulley is 54 inches wide, weighs 47,000 lbs., and has a diameter of 17½ feet. The rim velocity is, therefore, 5,660 feet.

The shaft appears to span 7¼ feet between the inside edges of its bearings. Though not an excessive span, the line engraving of the side elevation appears to indicate that it might have been reduced to 6 feet, and, had ropes been employed in place of a belt, the width of face of the rim need not have exceeded 36 inches, for 16 ropes of 1¾ inches diameter would only take this breadth of rim, and the shaft span would have been only 4½ feet. Indeed, the practice of some of our English builders is to bring the bearings within the line of the rim—close up to the wheel boss. We note the span of this shaft because the diameter upon the wheel seat is only 14 inches—a smaller diameter than would be usually allowed in English practice for a shaft like this.

That curious design taken up by Messrs. Musgrave, of Bolton, is described, with its triangular oscillating connecting rod. This engine was the one built for the Peel Spinning Company of Bury (Lanc.). It is quadruple and of 1,600 H.P., and its rope rim grooved for 36 ropes of 1⅝ inches diameter, and, therefore, nearly 7 feet wide, may be compared with the American belt rim of fully equal velocity, but 4½ feet wide for only half the power. The Bury engine is to work at 200 pounds, and has cylinders 18 inches, 26 inches, 37 inches, and 54 inches diameter by 54 inches stroke at 80 revolutions, the rope rim being 21 feet diameter, the horse-power per rope being 44½, an easy load. Though Messrs. Musgrave's engine is wonderfully compact and the triangular rod a very ingenious device for coupling a pair of cylinders on to one crank, and driving the air pumps at the same time, we cannot say we like the design altogether, though it seems calculated to give steady turning effort, an item not of very serious moment at present day speeds however. As with the American engine we would ask, why so unnecessarily great a span of fly-wheel shaft ?

For a neat horizontal design, another spinning mill engine, by Hick, Hargreaves & Co., of Bolton, is shown, as erected at the Nersky Thread Mills in St. Petersburg. This is an ordinary compound tandem to work at 90 lbs. and 50 revolutions, and give 1,600 H.P., with cylinders of 38 inches and 64 inches by 6 feet stroke. Only 30 ropes are allowed on the 32 feet drum, which weighs 84 tons. We may suppose the ropes are at least 1¾-inch diameter. All the piston and valve rods have metallic packing, and there is a Knowles supplementary governor. Here we have a class of engine that has always been very successfully applied by Messrs. Hick, Hargreaves & Co. to factory driving, with a single crank only. This inclines us to think that the scheming after regular rotative effort of the cranks of other engines may be a little overdone. Prior to the days of the present heavy fly-rims a practised ear could not detect any variation in the hum of a spinning room though the motive power was a pair of simple and comparatively slowly rotating beam engines. The resistance was of course very uniform, but experience shows that, so far as regards steady turning effort, single crank engines make a very good showing. The difficulty with varying loads is, of course, the presence in the cylinders of a quantity of steam out of proportion to the changed rate of work to be done. The load may vary, but the first cylinder alone takes note of it, the other cylinders go on utilising such steam as may have entered the first cylinder in response to quite a different position of the governor. A powerful argument this for the advocates of high reciprocation as distinguished from high piston velocity.—W. H. B.

THE NATIONAL TELEPHONE COMPANY'S STAFF DINNER.

The National Telephone Company's staff permeated the Holborn Restaurant on Friday evening. There was a bewildering array of red roses worn by many of the staff, when a company of 200 sat down to dinner. In every way the proceedings were eminently successful, and there was a cordiality which showed a high *esprit de corps*. Mr. Gaine, the general manager, occupied the chair, and showed a remarkable grasp of telephone business generally; at the same time he was well in touch with his audience. Amongst those present were Sir Albert Rollitt, Mr. Wallace, Mr. Dane Sinclair, Mr. G. Franklin, Mr. J. E. Kingsbury, and Mr. W. A. Smith. During the progress of the dinner, the Blue Hungarian Band played a selection of music in charming style, and interspersed with the toasts were half-a-dozen songs. The proceedings lasted four hours, and at no time was there any indication of the gathering lapsing into dulness. The brunt of the speech making fell on Mr. Gaine, who was felicitous in his remarks, and the company was equally appreciative of unintentioned jokes. The toast of "The National Telephone Company" was drunk with enthusiasm, and Mr. Roger Wallace proposed "The Science and Progress of Telephony." Mr. Dane Sinclair replied to this, and the toasts of "The Post Office," "The President and Vice-President," and "The Staff of the National Telephone Company," followed. Mr. Staats Forbes, the chairman of the company, Mr. Lamb and Mr. Preece, of the Post Office, and Lord Kelvin, were prevented by various causes from attending the dinner. It is to be hoped this is the forerunner of a series of annual gatherings, for their usefulness will be great.

Dundee Electric Lighting.—One night last week, Mr. Walter Brownlee, the city electrical engineer, afforded the members of the Dundee Institute of Architecture, Science and Art, an opportunity of inspecting the central station in Dudhope Crescent Road. There are at present 9,000 lamps connected with the mains.

REVIEWS.

*Theory of Electric Projectors**. By Andre Blondel, Engineer of Bridges and Highways. Paris: Lahure, 1894.

Most, if not all of our readers, will understand when they read the rather indefinite name of electric projectors, that we mean appliances for throwing the rays of an electric light in any desired direction and in a manner as little divergent as possible, such apparatus, though not applied to the electric light, were discovered in the last century, such as the parabolic mirrors of Lavoisier, Teulere, and Borda, and the lenses of Fresnel. The first projector for the electric light was constructed by Louis Sautter, in 1867, for the yacht of Prince Napoleon. It was composed of a Fresnel lens of 50 centimetres in diameter. This type came into extensive use for military purposes between the years 1867 and 1877. Col. Mangin next devised his celebrated refractive mirror, which has been extensively adopted.

Improvements have since been made by Schückert, Siemens Bros., Siemens & Halske, and others. Finally, in 1885, Schückert, of Nurenberg, working in conjunction with Prof. Munker, devised a method for obtaining parabolic mirrors in a single piece of thin silvered glass.

M. Blondel discusses in succession the characteristic elements of a projector, and the amplitude and the composition of the sheaf of rays. He calculates the luminous power and the divergence of the sheaf of an optical apparatus, applying the results to the various types of projectors, illustrating this exposition with numerous diagrams.

In summing up his results, the author submits that he has proved that a projector must be defined from a photometric point of view by its luminous power to a great distance on the axis and by the constitution of its sheaf of rays, and indicates a general theorem applicable to the determination of these data, showing how the calculation of the former leads us to that of the lustre apparent at each point of the emissive surface, and how the study of the second leads to that of the elementary divergences.

The results obtained for each kind of projector enable us to represent, by a practical approximation which is almost always sufficient, the value of the luminous power by a single empirical formula, extremely simple and applicable to all types, and to analyse completely the influence of the various elements of optics and of the lamp. From this analysis it results in particular that the *rôle* of the focal width is markedly indifferent from that commonly assigned to it.

He has established a comparison between the principal types of industrial projectors. He does not decide in favour of one projector rather than another, for the adoption of a mirror with a short or a long focus and of an oblique or of a horizontal lamp, must essentially depend on the circumstances of each case. As to projectors destined for the army or the navy, the officers of the different services are the best judges.

Elementary Manual of Magnetism and Electricity. By Andrew Jamieson. 3rd edition, London: Charles Griffin & Co., Limited, Exeter Street, Strand.

Little need be said about this book; it is in all respects an admirable treatise, and the addition of "How to make an electric bell" is one which will be appreciated, the directions being very precise and workmanlike. A further addition in the shape of the "Elementary Questions set at the 1892 and and 1893 Examinations in Magnetism and Electricity by the Science and Art Department," adds materially to the value of the book. It is rather a pity, we think, that someone does not take in hand and publish a complete set of answers to these questions, and also to the questions set by the City and Guilds of London Institute, of a similar nature.

Munro and Jamieson's Pocket-book of Electrical Rules and Tables. 10th edition. London: Charles Griffin & Co., Limited, Exeter Street, Strand.

Here again little need be said. Every care has evidently been taken by Mr. Jamieson to keep well to the front by additions, which the march of electrical science renders vitally necessary. The new matter includes the decisions of the International Congress of Electrical Engineers, held August, 1893, at Chicago, in regard to nomenclature and units; an illustrated description of a ballistic galvanometer and how to use it in obtaining magnetic induction, permeability, and hysteresis curves, as well as the capacity of a cable or condenser in absolute measure, is a very useful feature in the new addition. One hears at the present day a good deal with reference to such galvanometers, but very little indeed of a practical nature has been written about them; the explanations given are, however, we think, hardly as clear as is advisable for pocket-book purposes. We have also five different tests on self and mutual induction, four tests on the measurement of low resistances, one on the efficiency of dynamos by Cardew's method, together with a description of the internal arrangement of and connections of Evershed's ohmmeter, and for Crompton-Pochin arc lamp, and Lloyd's rules for ship-lighting. A number of tables relating to copper wire and incandescent lamps have also been added. It may be questioned whether something might not be done in the shape of eliminating antiquated matter, though there is, after all, not much which can really be regarded as obsolete.

* *Théorie des Projecteurs Electriques.*

MAGNETIC QUALITIES OF IRON.

Discussion on Mr. Kapp's Paper at the Institution of Electrical Engineers on February 22nd.

Prof. Hughes said the method of testing in this machine was one which he had adopted for a long time in his printing telegraph instrument. The armature was held by the standing magnet, and it was let loose by the current reversed to it. In that case they had the holding power just as in this, and it was a measure of the current. But they had this difficulty, that if the surfaces were not perfectly exact there was always a slight variation in the regulation. He should think the mean accuracy of this instrument depended very much upon whether the surfaces were very true and always in the same position.

Prof. S. P. Thompson said that an instrument which he had designed a year or two ago was suggested to him by the researches of Dr. Hopkinson. It would be remembered that in Dr. Hopkinson's method of testing the magnetic qualities of iron, he had a large massive block of soft iron, of a rectangular shape, with a rectangular hole slotted out, and the test pieces to be examined were two bars that met in the middle; a small exploring coil could be introduced between them. The two test-pieces were made to touch one another, and the magnetism was measured by the fact that one of the two test-pieces was pulled out and the exploring coil flew up, being pulled out sideways by a piece of India-rubber, and in that way cut across all the magnetic lines going through the test-pieces. It occurred to him in going through Dr. Hopkinson's researches, that the effect that he sought to measure by pulling the two test-pieces apart, and measuring the flow of magnetic lines from one to the other by the little exploring coil pulled out sideways, might quite as well be measured, for commercial purposes, by the mere pull of one test-piece on the other. He took two test-pieces and let one stick up against the yoke at one end and the other against the second test-piece in the middle of the coil, and then tugged at the test-piece. Sometimes the iron separated at one end, sometimes in the middle; so there was not much difference in the two attractions which overcame the magnetic lines. So the simpler method which he finally adopted was quite adequate for the purpose. In Mr. Kapp's instrument it was a pity that the iron had to be cut up into strips, but there was not much waste. He thought the same criticism might be passed upon this instrument as upon the other, viz., that the piece of iron not under test having the same cross-section as the piece that was, the allowance that had to be made was a large quantity as compared with a quantity of the same orders, the ampère turns required to magnetise the test-piece. If the cross-section of the other part could be enlarged very much indeed, he thought it would simplify matters, especially as the hysteresis question came in to cause further complication. The two corrections could not be used, so that the correction which was made for magnetisation at one stage of saturation would hold good as the correction for the magnetisation at another stage, whereas if the other piece of iron than that under test were made of very large cross-section, so that it never came near saturation, the same correction would hold good for it. He was engaged in research on the behaviour of masses of iron, such as were used in the first of Mr. Kapp's instruments, for the purpose of serving as yokes, having no magnetic resistance, and he had arrived at a most interesting point of view, viz., that a large sheet of iron, so large as to be practically equivalent to an infinite sheet, not less than 10 millimetres thick, acted towards all things that might be placed in front of it, as a magnetic mirror, giving, however, only negative images, and not positive images. He would like to suggest to Mr. Kapp, whether he could not show them some way of getting at the magnetic properties of iron not in a rod or sheet, but in a block, a cubic yard, say. It ought to be possible. Let there be a thin strip of ebonite; drill in that two round holes, lay in those round holes two small coils, the one to receive a current, the other two to give a cur-

rent to a galvanometer, a sort of transformer with no coil at all. Lay this on a block of iron and apply a magnetising coil. Somes lines would come up through the hole, depending upon the goodness of the iron below. A complete magnetic circuit might be made by another block of iron on the top. Then they had the magnetic reluctance, between the two blocks, and a small air gap between the two blocks. In that way they might have a method of mensuring the permeability of iron in the mass.

Mr. Steele said a long series of tests had been made at Messrs. Johnson & Phillips's on the magnetic properties of steel and iron used in the manufacture of dynamos and transformers, and he might safely say that the methods and instruments described by Mr. Kapp had yielded very accurate results, results which were consistent between themselves. The methods were such as to require a very short time for making the tests. With regard to the permeameter, just one precaution should be taken when making a sample bar. If, in the case of cast-iron or steel, a small sample was taken, only sufficiently large, to be turned to the required diameter, the results obtained on testing the sample in the instrument might prove considerably worse than the results obtained in actually testing the dynamo. This was due to the fact that the skin had not all been turned away, and therefore it was necessary to obtain a sample of considerably larger diameter than the size required. The samples had to be carefully faced at the ends. This took some time, and, as Prof. Hughes had remarked, an error might be made unless the end of the sample was placed properly against the plunger, and was placed in the right position. This difficulty, he thought, might be got rid of by using a small cap carefully faced at the end, this to be used for every sample. This would be a considerable saving in avoiding the necessity of facing up every sample, and the results would be more consistent between themselves; that was to say, the same face would be used for every sample tested. The testing machine with transformer plates had proved of immense value in testing samples of sheet iron received for transformer use. To have to make up a transformer to actually test the iron was a risky proceeding in case the iron turned out bad, and the transformer would be useless for commercial purposes. There was also a considerable saving of time in making up samples for test, for that might be done, and the test completed, in two hours, whereas, if a transformer were made up it would take a much longer time. The facility in making tests of this sort had helped in a large degree to reduce the losses in the transformer and placed the makers in a position to offer guarantees, and the efficiencies obtained now were quite high as compared with the efficiencies of a year or 18 months ago. Before them was a list of Kapp transformers at 100 frequency giving the iron loss with full-load efficiency for four standard sizes. The iron loss was only 0·95 per cent. of full-load, and the full-load efficiency was 97·4 in the case of a 20 kw. transformer, which, he thought they would agree, was very good.

Dr. Fleming said the instruments which Mr. Kapp had brought before them were of very great importance from the point of view of the manufacturer of transformers, and also from the point of view of those whom the Acts of Parliament called the undertakers. Mr. Kapp approached the subject chiefly from the point of view of those who manufactured transformers, and they were only too glad to have from him any of his very large experience in the manufacture, for he had succeeded in producing a very excellent transformer. Everyone would admit that what they wanted to know about transformers was the performance of the instrument when it was completed, and merely to have a determination of the performance of part of it, and from that to deduce the whole was not necessarily to get a satisfactory result. It was not necessarily certain, because you found the loss in a small specimen made up in a certain way to be a certain amount that that would necessarily give the figure of the total loss when made up in a particular transformer. There was an extra loss which might ensue if the transformer was not dry; that in in some cases was very marked. There were great discrepancies between transformers tested at different times and places which could be accounted for by the assumption that the transformers were tested at different degrees of dryness. This was not always loss taken up in evaporating water from the windings in insulation, but from the eddy current loss between the plates, if the paper, or whatever it was that acted as insulation magnetically, had moisture in it; and certainly it was very necessary in making any critical tests on transformers to make certain that they were properly dry. It was difficult sometimes in the ordinary way, because they could not raise them to a sufficiently high temperature without taking a great deal of time to drive out water from the paper or other insulation. He thought in all cases the cores of transformers ought to be baked to a fairly high temperature before being wound, and then, of course, care must be taken that they were not in any way spoiled before they were tested. Then there was another thing which it was also important to bear in mind, although one must hesitate about speaking too confidently, and that was that the loss in the iron seemed to depend upon the form of the E.M.F. curve. He had recently had an interesting correspondence with Mr. Blathy in which that question had been raised. Mr. Blathy tried the experiment of taking the same transformer and testing it on a machine which gave a true sine curve, E.M.F. curve, and then trying it on another machine in which it was known that the form of the E.M.F. curve was very different from the simple sine curve, and the result was that the transformer when tested on the simple sine curve gave a markedly higher loss than when tested on the other. That showed that where one had to specify exactly the losses in a transformer, it became necessary to specify the kind of machine on which it should be tested. One might be very much misled by experiments made with small samples. Prof. Ewing's sample of soft iron gave a hysteresis loss of a phenomenally small character; he had never met with any such. Manufacturers found some difficulty in repeating the quality of their iron. They would specify for a particular quality and make up certain transformers with it which came up to the specification or standard; they repeated that order and were unable to get it, and had to confess themselves disappointed in their iron. Nothing would be more practically important than to ascertain whether it was possible to get rid of hysteresis altogether, and whether it was not a thing which might some day be abolished. The question was partly an electrical one, partly a chemical one, and partly a mechanical one. It was certainly a remarkable thing how difficult it was to get rid of the smallest trace of manganese out of iron. One matter to which he desired to call especial attention was the fact that lamination of the iron did not necessarily eliminate altogether eddy current loss. For, if a transformer was constructed with iron bands, even of not more than 10 mils in thickness, and yet so arranged that the leakage field passed more or less perpendicularly through the iron, then eddy current loss would be created at full load in that transformer, though absent at no load. Hence, the full load loss could not be determined from experiments on small portions of the iron. This last fact made it essential to be sure that the method of testing the iron did not mislead the observer, when such iron was afterwards made up into transformers.

Mr. Sparks wished to ask very much the same question. When Mr. Kapp tested his sample bar as shown in fig. 1, did he find the results obtained in practice anything like those obtained during the experiment? Because the sample had to go through the operation of being drawn out; it was forged to a greater extent than an ordinary magnet block, and there was a chance of its being better annealed. The working up in a lathe would affect the sample differently to a large block, it being machined in another way. Under those circumstances one would imagine the results obtained would differ very greatly in the experimental bar from those which would be obtained when the iron was made up in the form of the field of a dynamo. He had made a great many experiments on samples, but the great difficulty seemed to be that even in testing one sheet there was an enormous difference between the results of different parts of the sheet. Then again, if they took a large quantity, a number of tons, they found marked differences in one ton over another, and it was almost impossible to get two bits made up at different times to give anything like corresponding results, making it impossible for makers of transformers to guarantee without having a large margin in hand; they could not guarantee down to the last limit, even to 1 or 2 per cent, otherwise they were very often caught. He would like to know what results Mr. Kapp had obtained, and whether the results with a small sample agreed within a small percentage with those when the iron was made up into transformers.

Prof. Perry would suggest to Dr. Fleming that instead of going to large works, like Elswick, for a piece of pure iron, if he wanted a small sample he should ask the cast-steel manufacturers of Sheffield, who made tool steel from the purest iron. He would then get very pure Swedish charcoal iron—not Siemens's steel, which was very often sold as charcoal iron. He thought Prof. Thompson's method was not a good one for testing iron in block. It was air resistance which was tested, and there was no saturation and no hysteresis at all. With regard to a remark made by Prof. Hughes, as to the reason why bad fitting produced such very evil results, it might not be known to those who had not to make to sell that if you wanted great lifting power in a permanent magnet all you had to do was to have the area of contact between keeper and magnet ridiculously small. On every square centimetre of area the attraction was proportional to the square of induction. For only a small area there was far greater intensity of induction. If they diminished the area, having the same total amount of induction, they would have an exceedingly increased force. In connection with this subject some of them may have been astonished at some results of his, published some time ago, on the permanent magnet induction that could be obtained in steel. He believed he gave results three times as great as anybody else had given. They could get an enormous induction if they properly shaped their magnet so that the poles were of very great area and the magnet had little lifting power. Taking Mr. Kapp's test specimen and slightly hollowing out the bottom so as to have an exceedingly small contact they might enormously increase the magnetic force.

Mr. Mordey asked whether the author had experimented on the effect of time in changing the carrying power of the bars. It might be remembered—he had alluded to it in a discussion there some time ago—that Lord Elphinstone and Mr. Vincent, a great many years ago, read a Royal Society paper showing what an enormous effect in lifting power could be got by very slowly increasing the weights. They found that if they took many hours, or two or three days, they could get the magnet to hold many times as much as would break the keeper away if the experiment were made quickly. Another point which was of interest to dynamo builders was the fact that the small test bars were not true samples of bulk. One often found that iron differed a great deal in the piece. He mentioned a drum dynamo in which the armature always pulled to one end. On investigation it was found that there was such a difference in the quality of the iron of one end of the bars to that of the other that an actual end pull was exerted in one direction. The particular part of Mr. Kapp's paper which had most interest for him was that dealing with transformer iron, and he agreed with the remark which had fallen from Dr. Fleming that there was at this moment, in connection with the building of electrical apparatus, no more important question than that of getting good iron. They were all interested in that. He had had a great deal of trouble on account of the inability of iron manufacturers to supply iron of anything like even quality, and the statement of Mr. Kapp that iron makers are now offering iron that will conform to definite specification as to watts per lb., was the result of the efforts of the Brush Company to obtain iron in that way. As a matter of fact, they ordered and obtained their iron to a specification of that sort, and as the specification was public property, he saw no reason why he should not mention the terms of

it. The standard taken was 2,500 lines per centimetre, and the loss at 100 periods was 0·38 of a watt per lb.; that was a standard very easily worked to, and the quality was exceeded to the extent of iron being obtained of 0·25 and 0·28 of a watt per lb. On the other hand it varied 60 per cent. above that standard, sometimes even out of the same case of iron. As far as his experience went, chemical analysis was absolutely no guide whatever to the magnetic quality of the iron. He did not say they would not get a bad analysis from impure iron; but they would get good iron and other iron which was almost exactly similar in analysis, but varying 60 or 70 per cent. in hysteresis loss. That would seem to indicate that it was a physical question, a question of condition and not of chemical composition. The criticism which he would make on Mr. Kapp's apparatus was one which had been already made, that it did not test the whole transformer, that there were parts of the iron circuit that were always in use, and to that extent, unless those parts were made so large that the effect in them was negligible, he thought the apparatus could be improved, and in the way Mr. Kapp had himself suggested at the end of his paper, by always testing iron in the actual transformer. He did not mean to make the iron up into actual transformers, but to make up testing coils and test in that way. This had for some years been their practice at the Brush Company's works.

Mr. Ranshaw thought the importance of testing armature iron was as great as that of testing transformer iron. A case had come under his notice where the hysteresis losses in iron were exactly twice in bulk what they were in the samples.

The President remarked that Mr. Kapp said in his paper that the method devised by Dr. Hopkinson and Prof. Ewing gave most accurate results, but the very perfection of those methods formed a drawback to their adoption in engineering works where highly trained experimenters could not be found; and then in another place he said the sample consisted of a bar accurately turned and faced. Judging from the remarks of Prof. Hughes and Mr. Mordey, Mr. Kapp had simply shifted the difficulty from being an electrical one into a mechanical one, because to produce those beautifully turned bars required a long time and a good deal of mechanical skill. He wished to show them the way in which they tested the magnetic qualities of iron at Woolwich. They would at once see that it was a very much simpler and safer method than Mr. Kapp's. The apparatus was based upon that of Prof. Ewing, and consisted of a brass tube 3 feet long and $\frac{3}{4}$ inch internal diameter, on which a coil was wound, which was in connection with a rheostat, a double key, with a battery which gave about 10 volts, and there was an exploring coil on the first coil which was connected with an ordinary galvanometer. Now what was done was to plot out the hysteresis curves of the various sorts of iron. When a piece of iron was put in, care was taken that it was not as long as the brass tube. Then a current was sent through the coil, varied by inserting more or less resistance by the help of the rheostat, and the kicks which the galvanometer gave each time the resistance was altered, were plotted down. The double-current key gave them the opportunity of reversing, so that they could get the complete curve. The area of the hysteresis at once gave the quality of the iron. There was no fitting in this whatever. They need not make the samples of the same length to compare them, but merely cut off a strip of iron from the block they wanted to test, put it in the brass tube and make the curve, which one man could do in a quarter-of-an-hour, and they knew at once quite accurately what quality of iron was before them.

Mr. Kapp, in replying, said Prof. Hughes had really struck the key-note of all the important objections to the instrument, and that was the difficulty of getting the surface so true that they could rely upon its contact. He had not told them all the details, but he must say that this was the outcome of a great deal of design; it had grown out of trying to overcome one difficulty after another. That difficulty of getting good contact was, of course, the most important. There was very little difficulty, however, with a proper lathe in turning a sample to exactly $\frac{1}{2}$-inch diameter. Moreover, the instrument was designed to centre itself; that was the object of the ferrule. Finally, all they had to do if they were in doubt about the surface, was to put a little red lead, bring up the plunger and see if the surface was evenly covered with red lead. There was no difficulty in getting the surface, not mathematically, but practically true. Moreover, they must not forget that this instrument was not for testing inductions of 2,000 or 3,000, in which case the question of surface would be of more importance, but for testing inductions of 10,000, when it did not matter if the surface did not lie on quite flat. He had taken the trouble to spoil one of the samples for the purpose of ascertaining that. Dr. Fleming had really touched upon an important matter, and taught him something which he ought to have seen before, but had not. When he had tested complete transformers he had laid certain of them, maids-of-all-work, aside to be used in testing subsequently. These maids-of-all-work got better and better, but never quite so good as the iron in the samples, though the difference was very small. It was interesting to find Mr. Mordey's specification tallying so well with his average; his was about 0·35, and Mr. Mordey's 0·38.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's) for 1894.—Published by H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. This directory comprises the names of 18,414 different individuals and firms, is divided into four sections, namely, British, Continental, American and Colonial, each of these being sub-divided into alphabetical and classified sections. There are about 800 pages consisting entirely of directory matter, making the book the fullest, as it is the oldest, electrical directory in the world. The price of the work is 4s., post free.

St. Olave's Lighting.—The Board of Works Surveyor has lately presented a report on the question of electric lighting. After consultation with Mr. Mackie he recommended the continuous current system. The number of lights required would be: For Tooley Street, Duke Street, and St. Thomas's Street, 32 arc lamps; and for the minor streets 386 incandescent lamps of 16 candle-power. Though the site necessary for public lighting need contain only 800 feet super, in view of future extension of the electric light station it would be necessary to obtain (in the centre of the district, if possible) a site of not less than 3,200 square feet. In the event of no sight being available permission might be obtained to moor on the Thames a barge which could contain the necessary plant. Taking a basis of a plant capable of supplying, in addition to public lighting, 1,000 16-C.P. lamps for private purposes, the charge for private use would have to be 7d. per Board of Trade unit, which charge would cover cost and working expenses. The estimated cost of lighting the district, exclusive of building site and cost of provisional order necessary if the board supply private lighting, Mr. Thompson gives as follows: Machinery and foundations for 32 arc and 1,386 incandescent lights, £2,950; 32 arc lamps and pillars, and erecting, £810; 386 incandescent lamps, fitted to existing gas lanterns, £649; cables, conduits, &c., for distributing current throughout the district, £13,520; opening trenches and making good, £3,340; or a total of £21,269. The estimated cost per annum is given at £2,429, made up of £741 for interest on first cost of £21,269, £988 for working, £550 for depreciation of plant, and £150 for lighting and cleaning, in addition to cost of lighting as at present; but against this must be set the revenue that might be obtained from the private lights or power provided for. The estimates are calculated on the supply of 1,000 lights in addition to the public lighting, but the cables and pipes would be capable of supplying, with a slight additional cost, any number of lights, or any power, that might be necessary for private use. The estimated capital cost, exclusive of building and site, of lighting Duke Street and Tooley Street only is given at £2,050; the annual interest and working expenses at £585.

Electric Light at Rothesay.—The new Glenburn Hydropathic Establishment has been fitted throughout with the electric light, at a cost of about £2,000. In the dining room there are 12 electroliers, each carrying 3 lamps. In the drawing room brackets are arranged round the walls, which carry both electric light and gas, and in the centre, hanging from the ceiling, are two 3-lamp electroliers. The ladies' room, billiard room, reading and writing rooms, and the recreation room, are all fitted up. The stage in the recreation room is complete with electrical footlights. This has had the special attention of the contractors, Messrs. Claud Hamilton, Limited, who have lately carried out the electric lighting of the Theatre Royal, Glasgow, and other important work in the Royalty Theatre, Glasgow, and Lyceum Theatre, Edinburgh. All the bedrooms and corridors, and the elevator cage, are fitted with the electric light, while in the larger bedrooms there are special portable electric lamps. All wires and cables throughout the building are of Silvertown make. The light is generated by a compound dynamo driven by two high speed vertical engines. The entire work has been carried out by Messrs. Claud Hamilton, Limited, of Glasgow, under the personal supervision of Mr. Hamilton, their manager, and the directors have instructed Messrs. Hamilton to maintain the lighting under their charge for at least a year. We understand that Mr. Hamilton has been engaged with all the electric lighting yet introduced in the Island of Bute.

Bury Electric Lighting.—The Electric Lighting Committee of the Town Council recently visited the central stations at Liverpool, Bradford, and Leeds. The borough engineer has presented a report showing that the system proposed for adoption at Bury is continuous current medium pressure, with accumulators, and three wires for distributing the energy. The pressure at the lamps is proposed to be 110 volts. Plant is proposed to be erected as a first installation of about 4,000 8-C.P. lamps, but the capacity for the building is such as to allow for 7,000 such lamps. The accumulator house will be fitted with 150 Epstein accumulator cells, fitted to maintain 2,500 lamps for two hours if a total breakdown occurred to the machinery. The cables are to be of the highest quality obtainable, laid either in cast-iron pipes or troughs, or bitumen, or earthenware. All cables to be insulated with vulcanised India-rubber. One member suggested the utilisation of waste heat from the corporation destructors for the purpose of generating steam in connection with the electric light. In reply it was stated that the electric lighting station would be at Whitehead Bridge, and if there was a destructor erected it would in all probability be erected at the same place. The committee would be prepared to consider the question of the utilisation of waste heat from the destructor, but at present they were advised that there was no successful station where this plan was adopted.

College Electric Lighting.—The London office of Messrs. Mather & Platt, Limited, have lately completed an electrical installation at Emmanuel College, Cambridge, consisting of a semi-portable engine developing 20 brake horse-power, driving an Edison-Hopkinson dynamo having an output of 140 volts and 120 ampères. The college buildings being distributed over a considerable area, special arrangements have been made for the distribution of the current and the equalisation of potential, and underground cables have been run to various centres. A large set of accumulators, capable of discharging at 120 ampères, has been supplied and erected, and the cells are of the Chloride Electrical Storage Syndicate's make. Some 300 lights have been erected in the college, the fellows' and masters' chambers, chapel, and lecture rooms, &c.

Drake and Gorham.—On Friday last the London employés of Messrs. Drake & Gorham, numbering upwards of 130, held their annual smoking concert.

Catalogues, Price Lists, &c.—It is becoming quite a general thing among enterprising firms to publish elaborate catalogues, and the one just to hand from Messrs. Crompton & Co., Limited, is special evidence of enterprise on their part. It is the first complete catalogue issued by the firm within the last four years, its production having necessarily entailed no end of labour and trouble, as well as great expense. When we state that there are about 200 pages of figured and other very detailed information, it will be easily understood what a laborious task the work of compilation has been. The set-out of the front cover and the general get-up of the book have been superintended with a fair amount of taste. There are numerous illustrations of the machinery, &c., described, some of them being wood engravings and others process blocks; the superiority of the former is very marked. The well-known Crompton dynamos and motors, of course, are dealt with in much detail, as are also all heavy classes of electric lighting apparatus. We cannot spare space to review the catalogue in detail, but in conclusion would remark that a section devoted to "Notes, data, and specimen estimates of costs relating to the transmission of power" should be very useful to those interested in this branch of the electrical business. The book closes with a telegraph code, a list of the principal electric lighting work, public and private, carried out by Messrs. Crompton, and a number of excellent testimonials, including a special one from the Southend Local Board in respect of the pier electric tramway.

Messrs. Weston & Co., of Dover, have sent us one of their January, 1894, catalogues of steam launches and launch machinery.

Newington, Priddle & Co., Limited.—Under a winding-up order made last January against this firm, a summary of the statement of affairs, together with the observations of Mr. C. J. Stewart, the Official Receiver in charge of the case, were issued to the creditors and shareholders on Wednesday last. The accounts show total liabilities £1,503 18s. 11d., of which £1,210 19s. 10d. is expected to rank, against assets £744 1s. 4d. The deficiency to the contributories is returned at £6,466 18s. 6d. No prospectus was ever issued. The nominal capital of the company was £7,000 divided into £1 shares. The failure of the company is attributed by Mr. R. W. H. Newington and Mr. E. Priddle to insufficent working capital. Mr. G. P. L. Pemberton further states that the small working capital, which should have been wholly used in the business, was partly locked up in the advance in connection with the phonautograph, which produced no immediate profit.

Bristol Electric Lighting.—Before the St. Michael's Ward Liberal Association, last week, Mr. W. W. Hughes lectured on the local electric lighting installation. In the course of his remarks, the lecturer stated that the plant at the station consisted of seven boilers, comprising a total horse-power of 2,300, and 27,000 8-C.P. lamps could be supplied. It was, however, deemed advisable at present to limit the number to 20,000. Already 13,000 lamps had been ordered. The returns of the lighting, Mr. Hughes believed, would not only pay for the interest of the money expended on the installation, but it would, he thought, keep the works in a state of efficiency and provide a sinking fund, which in the course of 25 years would be sufficient to pay off the whole of the expenses connected with the undertaking. He did not think the Council was prepared to sanction an increase in the lighting until a year or so had elapsed, so that it could be ascertained if the expectations had been realised.

Telephone Systems.—Mr. Sack, the late director of the German Government telephone service, has published a small book entitled, *Telephonbetrieb mit Klappenschrank mit Vielfachumschalter* The author compares the three systems of multiple switchboards now in use at the leading telephone exchanges of the civilised world, and speaks favourably of the latest invention which has been in successful operation for the past twelve months at the German telephone exchange. He explains the systems of Scribner, Kellog, and Mix and Genest respectively, and illustrates his remarks by means of diagrams which add interest to the brochure. In this last mentioned switchboard the separate test line is dispensed with, thus saving the operators straining their ears, the testing being performed with the galvanometer.

Monmouth Electric Lighting Scheme.—The Town Council met last week to receive the report of Messrs. Bramwell and Harris on the combined scheme for electric light and drainage in the borough, and particularly the practicability or otherwise of utilising the water of the River Wye as a motive power to work the machinery by turbines. The report fully approved of the scheme as set forth in the plans prepared by Mr. Lailey, C.E., and the Brush Electrical Engineering Company. Having thoroughly inspected the locality, they recommend that the electric generating station be fixed on a now disused watercourse at the Old Forge on the River Monnow, when a continuous supply of water, with a fall of nine feet, can be relied on all the year round. This arrangement would allow of the sewage pumping machinery being fixed at any convenient place, it being worked by electric motors.

A. Hall & Co.—This firm have secured the lighting of the Palace, New Brighton, consisting of a 32-H.P. gas engine, 100-light machine and switchboard. In the large hall they are fitting 106 16-C.P. lamps in brass electroliers. They are also lighting the theatre and skating rink attached to the palace, making in all about 200 16-C.P. lamps and half-a-dozen arcs. In addition, they are erecting their patent electrical sign-board illumination. Messrs. Hall have further secured the contract for complete electric light installation, including gas engine, dynamo, glow lamps and arc lamp for Mr. W. Boote, the Pantechnicon, Elizabeth Street, Liverpool, for whom they have previously put down a very successful installation at another of his establishments.

Launches.—On February 21st the steam yacht *Britannic* was launched from the works of the Thames Electric and Steam Launch Company at Eel Pie Island, Twickenham. A special feature in this yacht is that she will carry an electrical pinnace on her davits, the accumulators in same being charged from a specially designed plant on board, consisting of a single high-pressure vertical engine driving a small shunt-wound dynamo, all combined on one bed-plate and fixed in engine room. At night, when the electrical pinnace is not in use, the batteries can be utilised for supplying current to the electric light installation on board; the current for this purpose can also be supplied from the charging plant in the engine room. In a few weeks the company will launch a vessel for passenger traffic on the Thames; it will be fitted up with arc and incandescent lamps.

Electric Light in the West End.—Messrs. Rashleigh Phipps & Co. are at present engaged upon the installation of nearly 1,000 additional lights at Messrs. Marshall & Snelgrove's large premises in Oxford Street, and their new premises in Vere Street. A complete plant is being established to run these additional lights, large additions to the present engine room having been effected to accommodate the two engines and dynamos, and four sets of accumulators. This firm has also recently completed an installation of some 300 lights for the Hon. H. Sturt, M.P., at his new house 38, Portman Square, with great success; they are also engaged upon the lighting of some 20 other private houses in various parts of London and district.

Littlehampton Lighting.—The gas lighting of Littlehampton being considered unsatisfactory, Mr. W. E. Hayne, A.I.E.E., recently wrote to the Local Board suggesting the adoption of electric lighting. He considers that a company with a capital of over £10,000, might undertake the work and carry it on with a good profit. He has, so he says, negotiated with certain manufacturing electrical firms who would be willing to supply the requisite machinery, &c., and in the event of a company being formed, such firms would take payment in shares to the extent of at least £1,000. The board has referred Mr. Haynes' communication to a committee.

Electric Lighting of Ulverston Paper Works.—The Ulverston Paper Works have lately been lighted by electricity. The installation, which was carried out by Messrs. W. R. Thornton & Son, electrical engineers, of Duke Street, Barrow, consists of a vertical steam engine driving a dynamo by means of a leather link belt, and the total number of lights provided for is equal to 500 lamps, each of 8 candle-power; Edison-Swan incandescent lamps are used.

Liverpool Electric Lighting.—The Health Committee of the Corporation has decided to employ an engine at the refuse destructor in Chisenhale Street to utilise the steam generated by the destruction of the ashpit refuse to work a motor which will illumine the whole of the Corporation yards in Chisenhale Street with the electric light.

Electric Light at Manchester.—Messrs. Dobson and Barlow, of Bolton, have just placed an order with Messrs. Lowcock, Hill & Co., 2, St. James's Square, Manchester, for the lighting up of a portion of their machine shops with 120 inverted arc lamps. A large extension of the incandescent installation with dynamos has also been placed with the same firm.

An Electrical "At Home."—The Scarborough Electricity Supply Company took the opportunity of the Mayor of Scarborough being "at home" to give an electrical exhibition. The combined function took place at the Grand Hotel last week, when the principal residents of the district were present.

The Sunbeam Lamp Company.—We are glad to hear that this company is pushing its excellent goods, and from what we know the lamps will find as ready a market as they did before the days of the injunction. The annual meeting was held a few days ago when an encouraging report was presented.

Troublesome Arc Lamps.—The arc lamps in Glasgow City Hall frequently hiss, presumably during speeches, at any rate Bailie Primrose, at a recent meeting of the Town Council, laid a formal protest against the "frequent outbursts of hissing from the lamps." The troublesome lamps will shortly be ejected.

Chelmsford Electric Lighting.—At the last meeting of the Town Council the lighting committee presented an estimate for the lighting of the borough for the ensuing 12 months. The total cost would be £995, with £5 additional for lighting the public clock.

Mill Lighting.—In our notice regarding the lighting of the new mills of the Irwell Bank Company, at Stoneclough, we stated that the work had been carried out by Messrs. J. H. Parsons & Co. This should read Messrs. J. H. Holmes & Co.

Leeds Electric Lighting.—The members of the Leeds Association of Engineers recently visited the works of the Yorkshire House-to-House Electricity Company, Aire Street. Mr. R. W. Eddison conducted them round the station.

Electric Light at Windermere.—It is satisfactory to hear that the electric light is rapidly extending in the Lake district. The electrical works at Troutbeck Bridge, Ambleside, are supplying several country houses and hotels.

Edinburgh Electric Lghting.—The Town Council have decided that the charge for electricity supplied by the Corporation shall be 6d. per unit for lighting, and 3½d. per unit for motors.

Electric Lighting at Walthamstow.—A sub-committee is to enquire into the desirability of adopting the electric light.

Bournemouth Electric Lighting.—Mr. H. M. Sayers, now superintending engineer of the Companhia de Luz Electrica, Oporto, has been appointed superintending engineer of the Bournemouth and District Electric Supply Company.

The Sale of the Isle of Man Tramways.—The shareholders of this company have approved of the transfer of the undertaking to the Douglas and Laxey Electric Tramway Company.

Change of Address.—Mr. Robert Hammond announces that his address is now Ormonde House, Great Trinity Lane, E.C. (near Mansion House Station), London.

Electric Lighting of Shirley and Freemantle.—The Local Board of these districts, last week, instructed a committee to enquire into the cost of introducing electric lighting.

Woolwich and Electric Lighting.—The Local Board have deferred consideration of the question of lighting the Town Hall and board room by electricity for three months.

Halifax Electric Lighting.—Arrangements are being made by the Electric Lighting Committee to purchase the necessary land for electric lighting station.

Church Lighting.—The new church of St. Andrew, Dearnley, is lighted by electricity. Mr. Wilcock, of Littleborough, carried out the work.

Lighting of Manchester Conservative Club.—The contract for the lighting of this club has been placed with Messrs. Lowcock, Hill & Co., of Manchester.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackpool.—The trustees of the United Methodist Free Church, Adelaide Street, invite tenders for fitting up the church with electric light. Parties tendering to furnish their own designs. Information respecting same may be obtained from Mr. George Johnson, 16, South Beach, Blackpool.

Brighton.—March 12th. For the supply and laying under the streets and other places as directed of armoured and lead-covered electric cables, for the Town Council. Specifications can be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton.

Leamington.—March 12th. For the erection of five short lines of telephone wires, and for the provision and fitting-up of six sets of telephonic apparatus complete in all respects, for the Corporation. Plans and specification may be seen at the office of Mr. de Normanville, Corporation engineer, Town Hall, Leamington.

Stafford.—March 19th. For erection of buildings for the new central electric supply station, for the Corporation. Drawings may be seen and copy of specification, quantities, and conditions of contract obtained on application to Mr. J. F. Bell, engineer, Gasworks, Stafford.

CLOSED.

Blackpool.—For electric lighting of the Blackpool Tower buildings: Messrs. Verity, Sons, and Siemens Bros. for the plant, &c., £6,093 10s. For plastering: T. and S. Wardle, Manchester, £2,260.

Bolton.—The Electricity Committee of the Bolton Corporation have accepted the tender of Messrs. Siemens Bros., London, for an extra service main to supply current to the Town Hall. Mr. W. Rollitt has secured the contract for four transformer stations, to be placed at the junction of the principal streets.

NOTES.

Aberdeen Electric Lighting.—There was quite an enthusiastic gathering at Aberdeen last week, on the occasion of turning on the electric light for the first time. Prof. Alex. B. W. Kennedy was much applauded by those present.

Continental Telephones.—Telegrams from Copenhagen state that the first step has been taken towards the establishment of telephonic communication between Copenhagen and Berlin. The Finance Committee of the Folksthing has reported in favour of the proposal of the German Telegraph Department that the cable between Copenhagen and Odenser shall be so laid as to form a part of the eventual telephone line to be laid *via* Odenser, Kolding and Hamburg, to Berlin. The committee further approved the granting of a State subsidy for a regular steamer connection between the towns on the Limfjord and England.

Fire.—A fire occurred last Saturday morning in the electric storehouse of Crewe Railway Works. Much damage was done. A large number of acid tanks were destroyed.

Morley Electric Lighting.—Mr. Robert Hammond's scheme for electric lighting the town has been selected by the Town Council. He recommends the high tension system as laid down at Leeds by the Yorkshire House-to-House Electricity Supply Company.

English Anticipations.—The *Electrical World* has the following leaderette in a recent issue:—"In an otherwise able and interesting paper, descriptive of the electrical industry in the United States, Mr. Preece, of London, makes the following remark, in referring to the World's Fair:—'The American public were surprised to find how much we had anticipated their work.' We would be interested to know who those Americans were who expressed surprise at the supposed English anticipations, and also what those alleged anticipations were. We can think of only one, and that is the holding of exhibitions, as there were doubtless exhibitions in London before Columbus arrived here, and we do not think the American Indians held any. Probably Mr. Preece's sweeping statement was based on a passing flattering remark made by some Anglomaniac to tickle the vanity of an Englishman."

Lightning and Trees.—M. Dimitrie has found that different kinds of wood have very different conductivities for the sparks of a Holtz machine. Oak was easily pierced, but beech was highly resisting. The quantity of water present was not so important as the amount of oil. Woods containing starch, and but little oil, like oak and poplar, have much less resistance to sparking than those containing oil, like the beech. Pine, which contains oil in winter much more than in summer, is comparable with oak in resistance to sparks. When the oils are extracted by ether, these woods are as easily pierced as the starch varieties. Those containing starch are less easily pierced when living than when dead; the bark and foliage in all the trees are poor conductors. The conclusions accord with the observations that in a certain case 159 oaks were struck by lightning, as against 21 beeches and 59 pines. The danger of being struck, taking beech as the standard, is 5 for Norway pine, 33 for pine, and 48 for oak. The N.Y. *Electrical World* "Digest" has a note on this.

A Method of Making Large Steam Pipes.—A description of the making of a 20-inch steam pipe, by Chas. H. Manning, M.Am.Soc.C.E., in the current number of *Cassier's Magazine*, brings to mind the surprise often expressed by landsmen at the partiality of marine engineers for copper steam pipes. The frequent failures of the brazing of copper pipes are well known, also the liability to have bad brazing from even good firms. The pipe described is simply riveted mild steel, a stronger sort of that now old enough commodity, stove piping. Wrought-iron pipes have been in common use for years; a friend of ours made many hundred feet in New Zealand for fluming to gold workings, and there is no reason why good mild steel riveted pipes should not be used universally for steam purposes. We suppose copper has been used on shipboard because it gave somewhat to the working of a ship as compared with cast-iron, and for land purposes cast-iron is a little hazardous for modern pressures. Mr. Manning does not appear to have a good opinion of lap welded tubes, but given good material we should hardly doubt the safety of a good lap welded pipe. He advocates the formation of each length of a pipe from cone shaped belts, not parallel laid, similar to the old method of boiler plating, pointing the large end up hill so as to ensure drainage—a very good precaution. The riveted joints break joint at 90°, or are placed alternately 45° either side of the crown of a pipe. For 20-inch pipes to stand 160 lbs. sheet of $\frac{1}{4}$-inch thick is allowed, double riveted, the flanges being of $\frac{3}{8}$-inch stuff, die forged to shape, and of $\frac{1}{2}$-inch stuff where attached to valves or other castings. Of all items in steam engineering cast-iron pipes have longest held a position for which cast-iron is hardly suitable, and has only maintained itself so far because practical considerations of the founder have demanded a thickness greater than necessary for the pressures carried until lately.

Belfast Electric Lighting.—A resident electrical engineer is to be appointed by the City Council, at a salary of £250 per annum, the duties to commence on May 1st. The Council expect to be able to supply the light by September 1st.

Portraiture.—Mr. W. H. Bailey, M.I.M.E., &c., of the well-known Salford firm of W. H. Bailey & Co., Limited, is given the place of honour in this month's *Machinery Market*. A reproduction from a photograph is presented, as usual, as a supplement.

Cabul Keeps Pace with the Times.—Cabul is not far behind the times. There is a public electric light installation, electro-plating shops are in course of erection, and the telephone is also in vogue from the Ameer's chief palace to the workshops. The garden of this palace is lighted by a large arc lamp.

SS. François Arago.—This telegraph steamer, belonging to the Société Générale des Téléphones, arrived safely at Havre on the 1st inst. from Noumea, after an absence of nearly 8½ months. Having successfully laid the Australia-New Caledonia Cable, she loaded with nickel ore and returned home *viâ* the Straits of Magellan and Monte Video.

The Popp Company pay Heavy Damages.—The Paris Compressed Air Company and the Paris Gas Company, a few days ago, had judgment given against them in an action taken by the proprietor of the Larue Restaurant. This is in respect of an explosion that occurred there not long since. The total amount of the damages granted is 176,000 francs, the Popp Company paying three-fourths and the Gas Company one-fourth of that sum.

St. Pancras Electric Lighting.—The London County Council recently agreed to lend the Vestry £29,700, at 3½ per cent. interest, to be repaid in 25 years, for electric lighting. This arrangement the Vestry have declined to fall in with, and are borrowing £15,400 from the Prudential Assurance Company, at the same rate of interest, to be repaid within 42 years. The question of borrowing the remainder of the required money has not yet been decided.

Atmospheric Electricity.—Observations have lately been made from the Eiffel Tower to ascertain the voltage variations at different heights and upon different days. The diurnal variations are the more consistent the greater the height; there is a minimum voltage in the morning and a maximum in the evening. The morning readings agree, as to time of minimum, whether taken upon the top of the tower or on the level; the evening maximum occurs one hour sooner upon the tower than upon the level. The mean potential was 3,000 volts, frequently rising above 10,000. A *resumé* is given in the "Digest" of the N.Y. *Electrical World*.

Persian Telegraphs.—The *Evening News and Post*, under the heading of "Diamonds," last Saturday published the following:—

> There is no telegraphic system in the Shah's dominions.

In considering such a sentence a diamond of interest, our evening contemporary mistakes a chip of common glass for a valuable gem, as the statement is incorrect. There *is* a telegraphic service in Persia, part of it being worked by the Persian Government; but as to the quality of such service, we will say nothing more than that in the matter of inefficiency it can hardly be surpassed.

Muirhead v. Commercial Cable Company.—A full report of this case is appearing in our other columns. On Wednesday morning, when the Court again met, Mr. Walter having argued certain points in reference to American law, Mr. Bousfield replied on the whole case. He urged that the plaintiffs were not claiming a rheostat at a particular place, any more than they were claiming bridge condensers, or receiving condensers. They were claiming a certain novel organisation—a novel arrangement of old organisations or old instrumentalities. He submitted that the plaintiffs were, upon the evidence, and upon the law, entitled to judgment. His Lordship reserved judgment.

Walthamstow and Electric Lighting.—The Local Board have appointed a committee to consider and report upon the practicability of lighting Walthamstow by electricity.

Lectures.—Mr. H. Gibbons gave two lectures on Wednesday and Thursday last week in the Dunn's schoolroom, Plymouth, on the "Electric Current."

Edison's Latest.—Telegrams from New York on Wednesday stated that Edison has perfected his kinetescope for the photography of objects in motion, and has exhibited it to a small party. The main principle of the invention consists in taking a great number of impressions by means of a camera in a very limited space of time, thus obtaining a continuous photograph of the entire motion of the object or person selected. The photographs follow each other in such rapid succession that no lapse of time can be detected between the impressions recorded, and the series of pictures becomes, in effect, but one picture. The subject chosen for the first photograph by the new process was the well-known strong man, Sandow. The idea is old enough, but the means for carrying it out may be novel.

Derry Electric Lighting.—A Local Government Board inquiry was held last Friday regarding the Corporation's application for sanction to a supplemental loan of £5,000 for completing the electric lighting works. There was some opposition, but from what we understand it was far too weak to have any influence upon the mind of the Official Inspector. It has been found that the additional loan is absolutely necessary to enable the Corporation to efficiently complete the work at present being proceeded with. Were the £5,000 not obtained now, a far greater sum might eventually have to be expended. True it is, the extras which are now discovered to be necessary should have been originally reckoned for, but is the fact that they were not included in original estimate any reason for crippling the whole scheme? The opposition seems exceedingly unreasonable.

Manchester Telephone Wires.—It seems that at last the National Telephone Company and the City Council will come to terms in regard to the laying of wires underground for telephonic communication in Manchester. The committee authorised to arrange the matter have settled terms which they consider satisfactory to the Council as well as to the National Company. By this agreement, which will probably be shortly passed by the Council, the National Company pay the authorities 5s. per annum for each subscriber, the minimum number of subscribers to be paid for being 3,000. Other figures have also been settled, as charges for manholes, trunk wires, &c. The charge made to subscribers not to be increased without the Council's permission. All excavations of the streets to be done by the Corporation's servants.

The New Pacific Cable.—The Inter-Colonial Postal and Telegraph Conference held its third sitting at Wellington (New Zealand) on Wednesday. The Hon. J. G. Ward, the President, moved a resolution, seconded by the Hon. John Kidd, Postmaster-General of New South Wales, to the effect that, considering the important interests involved, both of a national and commercial character, in the establishment of the Pacific cable, the representatives should recommend their Governments to consider the desirability of entering into a guarantee for a period not exceeding 14 years, and to guarantee the interest at 4 per cent. on a capital of not more than £1,800,000 to any company undertaking the laying of the Pacific cable, the tariff not to exceed 3s. per word for ordinary telegrams and 2s. for Government telegrams, and 1s. 6d. for Press telegrams, to and from Great Britain and the colonies; and that the United Kingdom be asked to join the guarantee. Mr. Ward emphasised the fact that a guarantee of interest and not a subsidy was proposed, such guarantee not to exceed £72,000 per annum, which would be borne proportionately by Great Britain, Canada, and the Australian Colonies. With the exception of Samoa and the Sandwich Islands, the proposed cable would pass entirely through British territory, and the proposed route would admit of the Eastern Extension Company utilising the existing line from Australia to New Zealand.

New Work for Editors.—The ideas of newspaper correspondents regarding the duties of editors are exceedingly amusing. One of the most ridiculous instances we have met with in this direction is written to the *Chester Chronicle* by a citizen of that town, who opens his communication thus: "I beg to request you to supply the city with the electric light." Why do the knights of provincial journalism allow such nonsense to appear in their columns?

The Electrolysis of Alkali Salts.—It has been observed by Arrhenius that when an alkali salt is being electrolysed in aqueous solution, mercury forming the cathode, some time elapses before the hydrogen makes its appearance. This suggests that hydrogen is not the primary result of the electrolysis, but is due, perhaps, to the secondary action of the water of the solution upon the alkali amalgam, produced in the first instance by the discharge of the positive ion, *i.e.*, the alkali metal. The interval of time which elapses from the turning on of the current to the first appearance of the hydrogen increases very slowly as the strength of the current diminishes, and when the current is maintained constant at $\frac{1}{10}$th ampère, increases as the concentration increases, and as the temperature decreases. For equivalent solutions of electrolytes, having the same positive ion, this time is practically constant. Theory indicates that the electromotive force required for electrolysis increases at the outset, with the amount of electrolytic products already separated. But when secondary reactions take place, preventing the continuous accumulation of these products if the electrolysis goes slowly, the electromotive force required for electrolysis is determined almost solely by these secondary reactions. Evidently if the result of the secondary actions is the same as it is in the case of alkali salts, the electromotive force required for the decomposition will be practically the same also. Recent experiments have shown that this is approximately the case. If they are confirmed, there will be no necessity for assuming the primary decomposition of the water.

Electric Tramways Supplied from Lighting Stations.—The Incandescent Light Company, of Toronto, Canada, operating the Edison three-wire system, is supplying electric power to the local electric railway at 500 volts to supplement the power of the latter company's station. The incandescent station is equipped with Edison dynamos, shunt-wound for 140 volts, connected in pairs in the usual manner for a three-wire system. The increase in the voltage is accomplished by an ingenious arrangement of the switchboard, devised by Mr. James Milne, the electrician of the company. In carrying out his system, three additional bus bars were placed on the switchboard. The first of these was connected with the electric railway system at 500 volts, the second with the ground, and the third was for the purpose of connecting any two pairs of dynamos in series. The positive pole of each pair of dynamos was provided with a switch for connecting it with the electric railway bus bar, or with the third bus. The negative pole was also provided with a switch for connecting it with the grounded bus or with the third bus. To supply current at 500 volts, any two pairs of dynamos are connected in series. To accomplish this, all the switches on the machines to be thrown into the electric railway system are opened. Thus these dynamos are entirely cut out from the three-wire system. The positive pole of one pair, and the negative of the other, are then connected with the third bus, and in this way the four dynamos are connected together in series. The negative pole of the series is then connected with the grounded bus, after which the voltage of the series is regulated to equal that of the electric railway system, when the series of four dynamos is switched on to the electric railway bus. This arrangement has been in operation for a considerable length of time at Toronto, and has given entire satisfaction. Moreover, a pair of 60 kw. dynamos have been run with a pair of 100 kw. dynamos to feed the electric railway system, while the latter were connected with the three-wire system to which they were supplying a portion of their power. The load on the electric railway system is remarkably steady, and the variation in the voltage is so slight, as to be unnoticed in the lights when running the dynamos in this way. The most serious objection to running thus is that the negative side of the three-wire system must be grounded; but this is not a matter of importance, if the rest of the system be clear of grounds.

The City Electric Lighting.—On Tuesday last, the Commissioners of Sewers resolved to appoint an electrical inspector at a salary of £250 per annum.

Eccles and Electric Lighting.—The Town Council have instructed Dr. J. Hopkinson to prepare a report as to the most suitable system of lighting the borough.

Hampstead and Electric Lighting.—The Vestry have decided to apply to the London County Council for a loan of £5,000 (being a second instalment of the £25,000 previously applied for) for electric lighting purposes.

The Institution of Electrical Engineers.—On Friday next, March 16th, at 8 p.m., at a students' meeting to be held at 28, Victoria Street, Westminster, S.W., a paper will be read on "The Construction of Resistances," by D. K. Morris.

Appointment.—The Derry Corporation have appointed Mr. John Christie, of the Glasgow electric lighting station, as resident electrical engineer at the electric lighting works at a salary of £180 per annum. Mr. Christie was at one time a student at the Glasgow Technical College, and also once held an appointment with Messrs. Crompton & Co., Limited.

The Northern Society of Electrical Engineers.—At the Palatine Hotel, Hunt's Bank, Manchester, on Monday, March 12th, at 8 p.m., papers as follows will be read:—"Notes on Designing a System of Underground Electric Light Mains" by Mr. John H. Rider; "The Various Systems of Underground Mains and Methods of Laying Same" by Mr. S. V. Clirehugh.

NEW COMPANY REGISTERED.

Australasian Ore-Reduction Syndicate, Limited.—Registered by Wilson, Bristows & Carpmael, 1, Copthall Buildings, E.C., with a capital of £150,000, in £1 shares. Object: To acquire, by purchase or otherwise, the patent rights for Australia, Tasmania and New Zealand relating to a certain invention and process for recovering gold and silver from refractory ores; with a view to such acquisition, to adopt and carry into effect an agreement, made November 25th, 1893, between J. B. Hannay and A. R. P. Smith of the one part, and S. H. Waller, on behalf of this company, of the other part, and also an agreement to be made with T. A. Allan, and to carry on the business of miners and smelters in all or any of its branches. The first signatories (with 1 share each) are:—G. Cross, 23, Laurie Grove, New Cross, S.E.; E. H. Lawrence, Brentwood, Essex; R. T. West, 18, Rodney Terrace, Putney, S.W.; S. E. Spain, 4, Norwood Terrace, Dover; S. H. Waller, 206, Portland Road, South Norwood; J. Coleman, 420, Wandsworth Road, S.W.; A. P. H. Belcher, 8, Mount Terrace, Putney, S.W. The first directors are W. Bryant, A. R. P. Smith, R. Rabbidge, and T. A. Allan. Qualification, £250. Remuneration, one-tenth of the net surplus profits, divisible.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Akester Electric Syndicate, Limited.—The last yearly return of this company shows that out of a nominal capital of £15,000 in 300 £50 shares, 177 shares have been taken up. A sum of £37 10s. has been called on 77 shares; £2,837 10s. has been received in response to calls, and £50 is in arrear. Nine shares have been forfeited, and £5,000 has been agreed to be considered as paid.

Chagford and Devon Electric Light Company, Limited.—This company's yearly return, filed a few days ago, shows that out of a nominal capital of £2,000, in £1 shares, 324 shares have been taken up and fully paid. A sum of £750 has been agreed to be considered as paid.

British Electrical Engineering Company, Limited.—This company has lately filed its annual return, which shows that out of a nominal capital of £750,000 in 150,000 £2, and an equal number of £3 shares, 90,000 preference and 90,000 ordinary shares have been taken up, and that the full amounts have been called on each. A sum of £450,000 has been received.

Isle of Wight Electric Lighting Company, Limited.—The yearly return of this company, which was filed on the 23rd ult., shows that out of a nominal capital of £1,000, only the seven subscribers' shares have been taken up. There has been nothing paid.

Hove Electric Lighting Company, Limited.—This company's annual return shows that out of a nominal capital of £40,000, in £5 shares, 3,396 shares have been taken up, with £5 called up upon each of 3,350 shares, and £2 on each of 46 shares. The total received is £16,850 (including £33 paid in advance of calls), and £25 is outstanding.

Electrolytic Separation Syndicate, Limited.—The nominal capital of this company has been increased by the addition of £25,000, in £1 shares, beyond the registered capital of £25,000.

Incandescent Electric Lamp Company, Limited.——This company's statutory return shows that out of a nominal capital of £25,000 in 2,000 ordinary and 500 deferred shares of £10 each, 1,200 shares have been taken up, with £2 10s. called on each. A sum of £2,850 has been received and £150 is outstanding.

Europe and Azores Telegraph Company, Limited.—The statutory return of this company shows that out of a nominal capital of £200,000 in £10 shares, 16,700 shares have been taken up, with £5 10s. called on each of 11,132 shares. A sum of £61,226 has been paid, and £55,680 has been agreed to be considered as paid.

Electro-Protector Syndicate, Limited.—The statutory return of this company, dated the 6th ult., shows that out of a nominal capital of £10,000, in £1 shares, 7,607 shares have been taken up, with £1 called upon each of 607 shares. A sum of £500 has been received; £7,000 has been agreed to be considered as paid, and £107 is in arrears.

Crompton Electric Supply Company of Australia, Limited.—This company's yearly return shows that out of a nominal capital of £50,000, in 9,500 "A" and 500 "B" shares of £5 each; 3,115 "A" and the whole of the "B" shares have been taken up. A sum of £15,275 has been received in response to calls; £2,500 has been agreed to be considered as paid, and £300 is outstanding.

General Electrolytic Parent Company, Limited.—This company's statutory return shows that out of a capital of £24,000 in £1 shares, 22,507 shares have been taken up, and that 13s. 4d. has been called on each of 4,507 of these. A total sum of £1,500 has been received, £18,000 has been agreed to be considered as paid, and £1,504 13s. 4d. is in arrears.

The registered office of the company is now at 30, Moorgate Street, E.C.

Leeds and London Electrical Engineering Company, Limited.—The last return of this company was filed on January 11th. It shows that out of a nominal capital of £100,000 in 250 founders', 9,750 preference, and 10,000 ordinary shares, all of £5 each; 250 founders', 734 preference, and 5 ordinary shares have been taken up; and that £5 has been called on each of 250 founders' and 634 preference shares; £1 on each of 100 preference, and the full amount on the 5 ordinary shares. A sum of £4,545 has been received.

Lithanode and General Electric Company, Limited.—This company's latest return, filed February 1st, 1894, shows that out of a nominal capital of £100,000 in £1 shares, 20,642 shares have been taken up and the full amount called on each. A sum of £6,286 17s. has been received; £14,180 has been agreed to be considered as paid, and £175 3s. is outstanding.

Morecambe Electric Light and Power Company, Limited.—The last annual return of this company shows that out of a nominal capital of £15,000 in £1 shares, 50 founders' and 5,855 ordinary shares have been taken up, and that £1 has been called on each of 50 founders' and 5,004 ordinary shares. A sum of £4,766 15s. has been received; £851 has been agreed to be considered as paid; £299 is outstanding, and £11 15s. has been paid on 118 forfeited shares.

Pacific and European Telegraph Company, Limited.—This company's last return shows that out of a nominal capital of £100,000 in £10 shares, the whole amount has been taken up and fully paid.

Fowler-Waring Cables Company, Limited.—The yearly return of this company has just been filed. It shows that out of a nominal capital of £200,000 in 39,700 and 300 £5 shares, the whole of the 300 and 20,000 of the other shares have been taken up. The full amount has been called up on 20,000 shares; £100,000 has been paid, and £1,500 has been agreed to be considered as paid.

Swan United Electric Light Company, Limited.—This company's yearly return, filed during last January, shows that out of a nominal capital of £1,000,000 in £5 shares, 78,949 partly paid and 19,750 fully paid shares have been taken up. A sum of £279,851 has been received in response to calls; £98,750 has been agreed to be considered as paid on 19,750 shares, and £3,530 has been paid on 1,201 shares forfeited.

Wolverhampton Electric Light and Power Company, Limited.—This company has not done any business since December, 1889, and on the 23rd January the secretary wrote the registrar of joint stock companies, desiring that it should be struck off the register under the Act of 1880. The secretary states that there is no unsatisfied liability whatever on the part of the company.

Pontypool Electric Light and Power Company, Limited.—The annual return of this company shows that out of a nominal capital of £10,000 in £5 shares, 898 shares have been taken up, and that £5 has been called on each of 429 shares and £4 on each of 469. The amount of calls received (including £20 paid on shares applied for, but not allotted) is £4,021, and £20 is in arrear.

Peru Telephone Company, Limited.—This company's yearly return shows that out of a capital of £100,000 in £5 shares, only seven shares have been taken up. There have been no calls made.

S. Z. de Ferranti, Limited.—The annual return of this company has just been filed, from which it appears that the whole of the new capital of £100,000 in 2,000 preference and 8,000 ordinary shares, all of £10 each, has been taken up. A sum of £70 has been received, and the remainder of the capital has been agreed to be considered as paid.

Wrexham and District Electric Supply Company, Limited.—The yearly return of this company, filed on the 23rd ult., shows that out of a nominal capital of £20,000 in £5 shares, 115 shares have been taken up, and that nothing has been called or paid.

Merionethshire Electric Lighting, Power, and Appliances Company, Limited.—The registered office of this company is at 33, North John Street, Liverpool.

Oswestry Electric Lighting and Power Company, Limited.—The registered office of this company is situated at Oswald Road, Oswestry, Salop

CITY NOTES.

City of London Electric Lighting Company.

We are asked to state that the applications for the £100,000 5 per cent. debenture stock of this company, which has just been issued, amounted to £1,288,000. It is not too much to say that this is absolutely unparalleled in the history of electric supply, and we should imagine that applications exceeding the issue thirteen times has seldom been experienced in any commercial undertaking. We note, by the way, that a financial paper of uncertain reputation, which we shall not advertise by mentioning, has fallen foul of this issue. It pretends to dissect the accounts, but with a singular inappreciation of electric supply business. At any rate, the issue has not been affected by the presagings of this bird of ill omen. On the other hand, we notice that Mr. Wilson, in his *Investors' Review*, speaks kindly of the company.

The Cambridge Electric Supply Company, Limited.

The position of the company is fairly satisfactory. During the last six months 6,000 lamps of 10 C.P. have been added, and the directors are hopeful of an increased consumption. The company suffered to some extent through the coal strike. A profit of £268 has been made to December last, and it is anticipated that with the additional lamps lately connected, and those which will be shortly added, a substantial dividend will be paid next year.

We are sorry to see that the directors have felt it necessary to apply to the local authority for sanction to suspend the supply of current between the hours of 2 a.m. and 5 p.m. in summer, and 2 a.m. and 6 a.m. in winter. Although a supply during these hours may mean additional expenditure, we do not think that the company ought fairly to get out of it. As a matter of fact, a cessation of supply might be highly injudicious, and would tend to prejudice the company in the eyes of consumers. To give an instance, if electric light were required in the hours during which the company wish to suspend operations, it would as often as not be in a case of emergency, and consumers would soon draw comparisons between the reliability of electricity and gas.

We hope this application will not be persisted in, for in the ordinary course of things the company ought soon to be able to tide over the period of minimum demand.

The total number of units sold during 1893 was 65,586. We hope to be able to give next week the approximate cost per unit.

Reduced Prices at Preston.

The National Electric Supply Company, Limited, at Preston, announce reductions which take effect after April 1st; they are as follows:—7d. per unit, less 15 per cent. discount for cash, reducing the price to about 6d. per unit, an extra 5 per cent. discount off the net amount on quarterly accounts of over £25, reducing the price to about 5⅝d. net; a further 5 per cent. discount off the net amount on quarterly accounts of over £50, reducing the price to about 5¼d., and an additional 5 per cent. discount off the net amount on quarterly accounts of over £100, reducing the price to about 5d. net.

The Condition of Trade.

A change for the better has come over trade. It was suggested that the little burst of brightness at the commencement of the year would not last; but it is quite evident that those fears were groundless, for business has steadily improved since the first day of the year, and now matters are likely to be considerably helped by the state of the financial market. Money has practically become a drug in the market, and there is an increasing disposition on the part of investors to take their money out of the "old stocking," and put it into commercial undertakings. Of course, this cheapness has many drawbacks; it will bring many a nefarious scheme into existence, and there will be the usual attempts (too often successful) to filch money from the public. We are not at the present moment expecting any unusual schemes which are electrical and shady in their character, but it may not be long before company promoters secure some scheme which has more or less electricity in its composition.

It would gratify us exceedingly to see investors turning their attention to local electrical supply; for, in spite of the growth of municipal works, there is a good deal to be done by joint stock enterprise, and we know of many a genuine project of local lighting starved for want of capital.

An Interesting Document.

The company scandals of the past two years have had one important result; they have been sufficiently serious to warrant the Inspector-General on Companies' Liquidation issuing a report, which ought to be read and studied by every investor. We may deduce the following from the report, that "The prospectus of a company may be misleading; its estimates may be delusive and impossible; its property may be mortgaged unbeknown to creditors and shareholders, its articles of association may expressly provide that its balance-sheet shall be worthless, and its business may have been insolvent from the beginning, though it was proclaimed as the best thing going. All these things are possible under the existing company laws."

City of Bath Electric Lighting Company.

The cloud that has rested on this company for a considerable time seems to be lifting. The receipts for current sold are increasing, the income being £4,621 against £4,301, and the number of lamps connected has risen from 6,420 to 7,070. The most important feature in the year's working, or, we should say, in the last eight months, is the economies that have been effected by Mr. Metzger, who commenced his managerial duties in May. The last six months' working resulted in a profit of £464, and this is of immense importance when it is remembered that the accounts have hitherto shown a loss, the first six months of 1893 showing a loss of £276. Mr. Metzger is to be congratulated on the results.

We regret to see that the company is still suffering from an unwarrantable persecution at the hands of the town authorities, fines being imposed for the most trivial offences. However, we shall deal with this phase of the company's affairs in a future issue.

There have been several changes in the directorate, Mr. Garcke, Major-General Jervois, Mr. Garrett, and Mr. Massingham have retired, and their places are taken by Mr. B. H. Van Tromp and Mr. J. B. Wood.

The Elmore Companies.—Mr. Edward Reynolds, of Vickers, Sons & Co., Limited, has joined the board of Elmore's Wire Manufacturing Company, Limited. It is stated that the whole of the recent issue of £30,000 preference has been placed. A circular issued to the shareholders of Elmore's German and Austro-Hungarian Metal Company, Limited, states:—"Your directors regret that the issue of the 8 per cent. debenture stock, offered to the shareholders in their circular of the 10th ult., has not been taken up. This is unfortunate, as it leaves no alternative but to proceed with the issue of the preference shares referred to in that circular. On the other hand, the directors have pleasure in announcing that a contract has been entered into with the German Imperial Marine for the supply to the Government Docks at Wilhelmshaven, Kiel, and Dantzic, of all the copper tubes between 7 inches and 12 inches in diameter that may be required for the next three years, and it is imperative that the company be at once put in funds in order to carry this contract into effect."

Chelsea Electricity Supply Company.—The Electric and General Investment Company, on behalf of the Chelsea Company, are inviting applications for 6,000 6 per cent. preference shares of £5 each at a premium of 10s. per share, payable as follows:—10s. on application, £1 10s. on allotment, £1 10s. on April 16th, 1894, £1 on August 15th, and £1 on December 15th. The additional capital is required for the extension of mains into a fresh district in Chelsea, and to defray the cost of the buildings, works and machinery necessary to enable the company to cope with the increasing demand for current, and to repay temporary advances obtained for the purposes of these extensions.

Official Announcements re Companies.—The Registrar of Joint Stock Companies has published in the *London Gazette* notice to the effect that at the end of three months the names of the following, among other companies, will be struck off the register, and the companies dissolved, unless cause is shown to the contrary:—Brixton District Electric Light Supply Company, Limited; Deal and Walmer Electric Light Company, Limited; Electric Anti-Corrosion Company, Limited; West Middlesex Electric Lighting Company, Limited.

The United Asbestos Company, Limited.—The directors of this company intend to recommend to the shareholders the payment of the following dividends for the past year:—10 per cent. on the £10 preference shares; 6 per cent. on the £5 preference shares; 2½ per cent. on the ordinary shares; carrying forward a balance equal to 5⅜ per cent. on the ordinary shares.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum free of income tax, for the quarter ended December 31st last, and payable on the 22nd inst. The transfer books of this company will be closed from the 15th to the 21st inst., both days inclusive.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow the following to be quoted in the official list:—National Telephone Company, Limited—Further issue of £74,983 4½ per cent. debenture stock.

The City of London Electric Lighting Company, Limited.—Issue of £100,000 5 per cent. debenture stock:—Letters of allotment and regret were posted on Wednesday.

Commercial Cable Company.—A quarterly dividend at the rate of 7 per cent. per annum has been declared by the directors, payable on April 2nd.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 4th, 1894, amounted to £934; week ending March 5th, 1893, £929; increase £5; total receipts for half-year, 1894, £8,544; corresponding period, 1893, £8,672; decrease, £128.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of February were £3,600; as compared with £3,765 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February, 1894, amounted to £1,698, against £1,808 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in February, 1894, were £20,000; January 1st to February 28th, 1894, £41,000; corresponding months, 1893, £41,200; corresponding month, 1892, £40,800.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £3,001.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 28th.	Closing Quotation, March 7th.	Business done during week ended March 7th, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44	42 — 44	42	...
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	79 — 80	79 — 80	79½	79
2,932,680£	Do. do. Defd.	Stock	...	...	...	7 — 7½	7 — 7½	7	..
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11⅜— 12	11⅜— 12¼	12⅛	11⅜
18,700£	Do. do. 5 % Bonds	100	...	...	...	99 —102	99 —102	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	135 —145	135 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13 xd	12 — 13xd	12⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19 xd	18 — 19 xd	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	...	2 — 3	2 — 3	2⅞	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8 — 9	8 — 9	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	10⅜— 10⅝	10⅜— 11	10⅞	10½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	..	14⅞— 15⅛	15 — 15⅛	15⅛	15
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15⅞— 16⅛	15⅞— 16⅛	16 3/16	16
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —109	106 —109	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	114 —117	115½	114⅜
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	15⅜— 15⅝	15½—15⅞	15⅞	15 7/16
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	102 —105	103 —105	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	102 —105	103 —106	105	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	114 —117	115⅞	114½
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	102 —105	103 —106	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	102 —105	103 —106	103	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	103 —106	104	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4¾% §	4⅝% §	8½— 8¾	8⅝— 9	8 5/16	8 1/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅛— 15⅜	15⅛— 15½	15⅜	15 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗% §	8⅗% §	...	20½— 21½	21 — 22	...	...
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	104 —107 xd	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	42 — 45	42 — 45	44	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	107 —110	104 —107 xd	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	⅛— 1⅛	⅛— 1⅛	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	2 — 3	2 — 3	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4½— 4⅝	4½— 4⅝	4 5/8	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14⅓— 15⅓	15 1/16	15 1/16
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	14⅝	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅛— 5⅓	5⅛— 5⅓	5 1/16	5 1/16
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	113 —115	113 —115	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	..	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid ...	1	2½%	3⅜%	...	⅛— ⅜	⅛— ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5⅓— 6⅓	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	113 —118	113 —118	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1⅓— 2	1⅓— 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	98 —101 xd	99⅛	99¼
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 2½	2 — 2⅛	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	97 —101	97 —101	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7 — 7⅛	7⅛— 7⅜	7⅜	7⅛
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5⅝— 6	5⅝— 6	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1⅞— 2⅛	1⅞— 2⅛	2 1/16	1⅞
178,200£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	104 —107	104 —107	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1⅛— 1⅜	1⅛— 1⅜	1 3/16	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	9¼— 10½	10 — 10½	10½	10
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	8½— 9½	8⅛— 9⅛	8⅞	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	105 —108	106 —109	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	113 —118	113 —118	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	103 —106	100 —104 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4 — 5 xd	4 — 5 xd	...	...
40,000	Cityof London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	10½— 11½	11 — 12	11½	11
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	12⅝— 13½xd	13 — 13½xd	13½	12⅝
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5 1/16— 5 3/16xd	5½— 5⅝	5⅝	5⅜
15,000	Do. do.	5	4½%	5 %	...	6⅛— 6⅜xd	6½— 6⅝	6 7/16	6½
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000	10	1 %	2 %	...	8 — 8½	8¼— 8⅝	...	...
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	106 —109	106 — 109	107½	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5⅛	4½— 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	6¼— 6⅜	6 — 6½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8 — 8½	8 3/16	8
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	5½— 6 xd	5½— 6 xd	5 1/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 28th.	Closing Quotation, March 7th.	Business done during week ended March 7th. 1894. Highest.	Lowest.
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000	3	...	6 %§	6 %§	2⅝— 2⅞xd	2⅝— 2⅞xd	2 11/16	2⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 %§	6 %§	2⅛— 2⅜xd	2⅛— 2⅜xd	2 5/16	...
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	104 —107 xd	106 —109 xd	107	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32	27 — 32	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 %§	7 %§	7 %§	3 — 4	3½— 4	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	97 —102	97 —102	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼— ⅜	¼— ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½— 2	1½— 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	3/16— 5/16	3/16—	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	7/16— 11/16	7/16—	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1/8— 3/8	1/8—	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §§	*nil* §§	*nil* §§	½— 1½	½— 1½	...	...
12,134/	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½— 5½	4½— 5½	...	...
9,600/	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6 — 7	6½— 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24 xd	23 — 24 xd	23⅞	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —106	103 —105	...	...
11,334	International Okonite, Ltd., Ord., 22,667 to 34,000 ...	10	5 %§	...	...	1 — 2	1 — 2	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	5¼— 5½	5¼— 5½xd	5 3/32	5
6,295	† Do. do. Pref., £8 paid	10	...	...	...	9 — 9¼	9 — 9¼xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 %§	10 %§	7½%§	2 — 2½	2 — 2½	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41 xd	39 — 41 xd	40½	39¼
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅞.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4¾—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6⅛—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅛—6⅜.
Do. do. £3 10s. paid, 4⅛—4⅜.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4⅛—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Some Notes on the Electric Lighting of the City of London.

(*Read by Major-General Webber on February 8th*, 1894.)

(*Concluded from page* 258.)

Conductors.

As has been stated, the primary alternating current conductors were concentric 0·154 inch, with high class insulation; the high tension continuous current conductors were 7/16's concentric, except where the lamps are connected, also with high-class insulation, and the secondary conductors on the three-wire system of various sizes has Callender extra standard type insulation.

The two first were drawn into 2½-inch and 1¼-inch wrought-iron tubes respectively.

The last was drawn into the three-way Callender-Webber casing, manufactured of three sizes—namely, with 1½-inch, 2-inch, and 2⅜-inch ways; in each of those the third way is smaller than the other two. (See the samples on the table.)

The largest were for feeders where necessary, and the two smaller for distributors.

In the eight sub-district areas shown on the map (Plan No. 20) it is seen that no consumer's terminals would be more than 100 yards, measured along the main, from a transformer station; consequently, allowing the Board of Trade drop of 4 per cent. above and below the normal, the section of cables first drawn in, the maximum areas of the three conductors, taken together, was five-sixths of an inch, and very few feeders, except quite short lengths, were necessary.

It was considered that for a considerable time to come this would comply with a demand of at least three lamps per yard of frontage, the frequency of transforming stations being maintained. The impedance due to retardation was therefore negligible with those sizes.

The cable specifications giving the special conditions under which the manufacturers had to tender (of which a copy will be attached to this paper) had some special features, namely—

The same results of insulation as were prescribed for the tests at the maker's works were required after each length of cable had been drawn in, in the presence of the maker if he wished it, and before joints were made in it.

The maintenance of the insulation, except at joints, was guaranteed by the maker during three years from the date of it being drawn in, and if within that time the dielectric had deteriorated, the maker was to replace the cable.

With a view to the company having the advantage of the market rate of the price of copper at the date of the quotation, the contractor was required to state the number of tons of copper, made up in insulated cable, for which he would receive orders at that rate during one year.

As it became soon apparent that in each of the eight sub-districts above referred to, separate transforming stations might not be obtainable, the question of a distance between them probably greater than had been calculated on required consideration, and the consequent enlargement of the sectional area of the copper in the conductors.

The first point that had to be considered was as to the saving that could be effected by the use of hollow-cored cable. With alternating currents having a frequency of 100 there is an inequality of distribution of the current over the cross-section of the cable, and for practical purposes the penetration may be regarded as not exceeding ¼ inch from the outside of a cable of stranded copper, and therefore, if above ½ inch diameter, the copper in the centre of the strand is not useful.

These conditions led to the adoption of the Callender hollow cables for sizes varying between 0·4 and 0·7 of an inch sectional area as the simplest and cheapest form.

For instance, such a cable having half a square inch section of copper was made up of 38 No. 10's, or 30 No. 9's, in two layers round a hempen core, when the outer diameter of the copper is 1·05 inch.

For anything over ⅝ square inch section of copper it was apparent that some form of multiple strand would have to be adopted; but for the supply then contemplated (even with only 600 ampères per square inch density) the maximum of 0·7 of a square inch was sufficient to provide.

As regards joints and jointing—that very important matter both in first cost and maintenance—I had examined every form that in 1891 had been before the electrical engineering world, and at that time had no reason to alter the opinion formed from long experience, that only when forced to adopt anything else by the construction or dielectric of the cable, could I recommend anything more simple, practical, or durable, than the joint made of the same material and of the same form of covering as the cable itself; and this is applicable to both straight and T joints.

As regards the experience gained by the company in the matter of their mains since July, 1892, I shall hope the Institution may have the most instructive information from the engineers who carried on

the work after I retired from it. The best qualified is Mr. G. H. Nisbett, who since the autumn of 1890 had been my right hand in all matters connected with electrical distribution, and whose intimate knowledge of every part of the City work made it absolutely essential that he should pass from my service to that of the company when I left it.*

Public Lighting.—Lamps.

The lamp-posts and lanterns first erected in 1891 by the contractors, to the number of 72, in some of the main thoroughfares, under the pioneer contracts, did not meet with the approval of the Commissioners, and had all in time to be replaced.

The only portion which was allowed to remain was the lantern which had been designed by the Brush Company, and which I have illustrated, and called the "Raworth" lantern. My own views had advocated a different shape, having a wide pagoda roof, and sides at smaller angle to the horizontal.

In the case of the Raworth lantern, which is in use throughout the City, the dimensions were found to accommodate the Thomson-Houston arc lamp as well as that of the Brush; the interior is easily accessible; and the lamp, instead of being suspended, stands on a porcelain insulator. The other details were shown on the drawing, and a sample was exhibited.

As regards glass, Colonel Haywood was very particular in selecting one that was least absorbent of light, while being sufficiently diffusive of the arc.

The first sample, put in by the Brush Company, which gave the effect of there being four small blurs of light inside, was rejected as being too absorbing, and perhaps requiring too much labour in cleaning.

These samples of glass were submitted to the engineer, and tested by him in three street lanterns in use. They were, respectively:—

	Thickness. Inch.	Per cent. loss by absorption.
Ground glass	0·058	... 46·24
Opal	0·072	... 25·18
Rippled	0·145	... 21·73†

The last was approved, and is now in use, and is the cheapest.

The lamp-posts, as finally designed and approved by Colonel Haywood, are in two pieces, the base having two forms; the smaller base, which is round, is fixed in the narrower footways.

As regards the shaft, one matter which required careful consideration was the means of assisting the lamp-trimmer to ascend and descend.

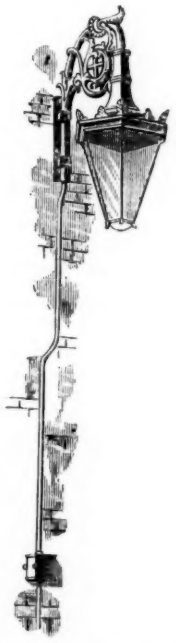


Fig. 20.—Lantern and Bracket, perspective, and Pipe under, &c.

In any case, fixed projections below the lantern upon which the man can stand at his work are necessary. Fixed projections, or means of attaching them, were not admissible on the ornamental base; but something had to be done to assist the man to mount the shaft, so as to save the carrying and use of a long ladder in the streets. The permanent attachment of steps, for obvious reasons, the Commissioners would not allow.

Three methods were proposed, namely:—

1. By the Brush Company, in which short pieces of rod iron, with a round head at each end, were passed into holes in the hollow shaft at intervals on alternate sides. These rods lay concealed all except the heads when not wanted; when in use, they were pulled out as far as the head on the rod within the shaft would allow.

2. By Colonel Haywood, which consisted in a structure like a parallel ruler, concealed in and bedded in each side of the shaft. When shut up, no evidence of its existence could be seen; when opened, the whole has the appearance of a ladder with a centre stave, and, but for extreme complication and costliness, it might have been a very excellent design.

3. The plan which suggested itself to me was very simple, and has been adopted. It consists in using alternate side holes in the shaft, which are not conspicuous, and in having six or eight portable steps of light steel, which can be securely hooked into the holes as he ascends, and taken out by the trimmer as he comes down the post.

Where the footways are very narrow, and posts are inadmissible, it became necessary to use wall brackets; of one of these an illustration is given. The suspended lantern is the same in design as that on the posts, with some small differences in detail. It took a considerable time for the Commissioners to obtain the wayleaves for such heavy attachments to private buildings. The suspension gear was specially designed to allow the lamps to be independently and rigidly suspended inside the lantern, while the lantern itself is free to swing slightly and swivel round.

In both cases—namely, in the base of the lamp-posts, and in a box fixed to the wall under the bracket—an absolute cut-out switch on an incombustible insulating base, approved by the Board of Trade, is provided. Each contractor has his own form.

In connection with fixing the posts more difficulty than might be expected was found. The base plates below the ground could not be by any means uniform in pattern. It was impossible to tell before the ground was opened whether the posts could be solidly supported by a deeply set base, or by one that spread out under the ground.* Several forms of modification of these conditions had to be provided for. In some cases heavy masonry and concrete had to be cut through and replaced.

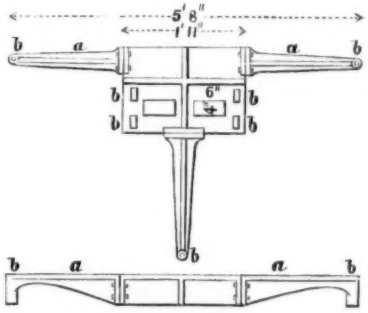


Fig. 21.—Underground Base of Lamp-post.

Of the 371 arc lamps contracted for in the eastern and central districts, in March, 1892, the positions of 340 only had been decided on. Of the 340 points 37 were brackets. †

The contracts with the Commissioners provide for the substitution at 906 points of glow lamps of not less than 200 watts ‡ for gas lights throughout the City where arc lights have not been put up.§ The contracts with the two manufacturing companies specify that they are to supply and erect 100 and 200-watt series glow lamps; all arrangements in connection with the first installation to be experimental.

The carrying out of these arrangements are still in the experimental stage. The Commissioners had the power to compel the company to complete them in the eastern and central districts by May last; but in withholding their engineer's order to have this done they have, I think, acted wisely in the interests of public lighting by glow lamps.

At the beginning of this paper I stated that the experiment on the

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* I cannot refrain from also mentioning here two indefatigable assistant engineers on the same duty—namely, Mr. Buck (late R.E.) and Mr. Bates.

† These tests were, I understand, made by Mr. Preece.

* In erecting the posts extra expense was incurred through having to open the ground a second time after the trench for the mains had been made. The Commissioners were responsible for this, owing to delays in approving of the patterns, and in finally deciding on the actual points to place each post.

† The weights and costs of these posts, above-the-ground brackets, and lanterns are as follows:—

	£	s.	d.
A large base weighs 9 cwts. 2 qrs., and costs ...	6	0	0
A small base weighs 6 cwts. 3 qrs., and costs ...	4	10	0
Each shaft and lantern gallery weighs 3 cwts. 1 qr., and costs	1	18	0
Each lantern weighs 3 qrs., and costs	7	0	0
Each bracket weighs about 1 cwt., and costs ...	2	2	0

‡ The prices to be paid by the City for glow lamp lighting is (sunset to sunrise):—

For a lamp of 200 watts ... ... £10 per annum.
" " 100 " ... ... 5 "

§ It may here be stated that as early as 1888 every point in the City where arc or glow lamps would be likely to be required had been surveyed and plotted, under my superintendence. The deviation from that design has been very small.

Holborn Viaduct in 1882 had brought discredit on this means of public street lighting.

The experiment now going on by the City Company in Basinghall Street is, I think, only calculated to produce the same result; but it is to be hoped the Commissioners will be as well advised in this matter as in the past.

The principles detailed by Mr. Trotter in his admirable paper before the Institute of Civil Engineers on public lighting by electricity are equally applicable in the case of glow lamps as in that of arcs. His dioptric lantern, which we have known ever since the days of the Inventions Exhibition, is the mathematical example of that for which he contends.

It is many years since, at the Society of Arts, in a paper on glow lamps, I demonstrated that the exposure of the filament to the eye, or the eye to the filament, is an abomination.

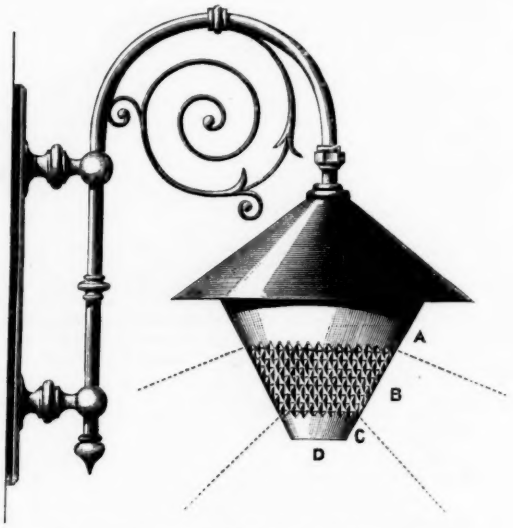


Fig. 22.—Wall Bracket, Glow Lamp Lantern.

I do not attempt to supplant Mr. Trotter's originality by showing a sketch of a street lantern with a hood, and inverted truncated glass cone underneath, the glass being cut up throughout a zone of its surface into diamond-pattern facets. There is nothing geometrical in their form (though there might be). They are only intended to intercept the direct view of the filament, within an area of space outside the lantern, and diffuse the rays of light from it. The simplicity of the design as regards convenience, &c., will, I hope, commend itself to the Commissioners; and I believe that, if posts in the small thoroughfares and courts were made entirely to disappear, and light ornamental brackets, with lanterns such as I have illustrated, were used, the City would in this respect have also taken the lead, and have set a good example to all other municipal bodies.

This paper, as its title shows, only deals with a portion of the great work of lighting the City of London. Necessarily, my duties as engineer up to July, 1892, required my superintendence of the starting of many works at present far from completion; and while in every case I have been careful to avoid enlarging on matters which could be better described by the engineers more directly responsible, obviously there are also several matters which might be regarded as more or less confidential. These I have avoided, and in selecting illustrations from figures have confined myself to those previously accessible to the profession.

In concluding, I hope I may be allowed to state that never was an engineer better served than I was by my staff, and that each and all fully justified their selection, equally those who were new to me and those who were old friends. It is no flattery to them to believe that my severance from the position of being their chief has in no way lessened the value of the services which they have since rendered to the shareholders of the City of London Electric Light Company.

LEGAL.

Muirhead v. Commercial Cable Company.

In the Queen's Bench Division of the High Court, the case of Muirhead v. the Commercial Cable Company was continued, yesterday week, before Mr. Justice Kennedy without a jury. The plaintiffs claimed £3,566 for royalties due under an agreement giving the defendants the right to use certain patents belonging to the plaintiffs for the transmission of messages simultaneously in opposite directions over the same conductor. The defendants paid £135 13s. 5d. into Court for royalties to July 1st, 1891, and denied further liability. They further pleaded that on July 1st, 1891, the English, French, and Canadian patents came to an end.

Mr. R. B. Finlay, Q.C., Mr. Bousfield, Q.C., M.P., and Mr. E. H. Pollard, appeared for the plaintiffs, instructed by Messrs. Trinder and Capron; Sir Richard Webster, Q.C., M.P., Mr. J. Fletcher Moulton, Q.C., and Mr. A. J. Walter, instructed by Messrs. Budd, Johnsons and Jecks, were counsel for the defendant company.

Mr. Finlay said the plaintiff was the patentee of a very ingenious system for the purpose of what was called duplex telegraphy, and held a good many patents with reference to duplex telegraphy. On January 2nd, 1884, he granted a license to the defendant company for the use of these patented inventions. The amount in dispute was very much greater than the sum claimed in the action, because the decision of this action involved settling the question whether the plaintiffs were entitled to royalties from July, 1891, to November, 1897, that being a sum of about £45,000. The agreement of 1884 was made between the plaintiffs, John Muirhead, Alexander Muirhead, and Herbert Taylor, and gentlemen representing the Commercial Cable Company. The agreement stated that plaintiffs were the inventors of a special mode of construction and combination of accumulators and apparatus, called the patented duplex apparatus, having for their object the transmission of messages simultaneously in opposite directions over the same conductor. Then followed a list of the patents. For England, patents were taken out in 1874, 1875, 1876, and 1877; France, 1875, with certificates of addition of 1877 and 1878; Canada, 1878 and 1878; United States of North America, 1878 and 1878, and November 16th, 1880, which was the patent his Lordship would presently have to deal with in this case. The inventors granted to the company the right to apply their patented duplex apparatus to the cables from Great Britain and France to America. The grant was made for the whole period during which the patents should last. The inventors bound themselves during the continuance of the agreement to give the benefit of all improvements and modifications which they might discover, whether they were protected by patent or not; but in that case the contract was to be prolonged for a period equal to the terms of any new patents that might be taken out. The consideration was set out in the agreement in this form: "As consideration for the above concession, the company shall during the continuance of this agreement pay to the inventors the following annual revenue:—1. For the application of the patented duplex apparatus to the Atlantic or main cables an annual royalty for each cable of £1,250 sterling, subject, however, to increase in manner hereinafter mentioned." The following paragraphs stated that if the increase in the rapidity of transmission exceeded the amount taken as the datum on which the £1,250 was to be calculated, there was to be a corresponding increase in the amount of royalty paid. Article 9 of the agreement provided that it was to be construed as an English contract. The defendants thus became licensees of Messrs. Muirhead's patent. The object of duplex telegraphy was that they could use the same cable at the same moment for transmission of messages from America to England, and from England to America. The learned counsel proceeded, by means of diagrams, to explain to the Court the principle upon which the system of duplex telegraphy is worked. One great object in duplex telegraphy was to ensure a perfect balance between the two currents which passed up the two arms. If a perfect balance were kept up on the two arms while a message was being sent only from the American end, there would be no cross current at all in the branch where the receiver was situated, because there was an equal influence exerted from either end. The rheostat was an instrument the total resistance of which was 5 ohms. That was divided into a resistance of a quarter of an ohm between each of the two studs, which were denoted by dots on the diagram. When the pointer was moved a stud, it took off or added a resistance of a quarter of an ohm. There was a total resistance of 5 ohms distributed round the rheostat between the studs, and if the pointer was moved in the direction of the upper arm the distance between two studs, a resistance of a quarter of an ohm would be taken off; if the operator moved it from the upper arm of the bridge away from it, he put on a resistance of a quarter of an ohm, and so with regard to the other. This was a very important part of the combination which formed the subject of this patent. The object of it was that the operator saw at once, as soon as he depressed one of the keys, if there was any agitation in the cross line on which was situated the receiver. If there was any current passing through there, the operator knew that the balance of power was not perfect, and he corrected it by moving the handle of the rheostat to the one side or to the other. In that way the operator was able to establish and to retain a perfect balance between the two arms of the bridge. He now came to the distinctive feature of duplex telegraphy. The effect of both sides working at the same time was that they had both batteries of equal power; both these currents met in the submarine cable, no current at all passed through the submarine cable, but the signalling went on exactly as it did. Starting from the American end, the portion of the current which had passed up the upper arm of the bridge not being able to go along the cable, being met by an equally powerful current from the English end, passed down through the cross wire on which was situated the receiver, with the result that an impetus was given exactly the same as would have been communicated by a current coming from the other side. As long as the current from the English side lasted, and exactly equalised the current from the American side, the current from the American side which had passed up the upper arm of the bridge went down through the receiver, and there agitated the signal just as it would have been agitated if the current had come from the English side.

Mr. Justice Kennedy: In that case your American message does not travel through the cable?

Mr. Finlay: No, it does not; it finds a home in this receiver. What is communicated to the receiver is the exact equivalent to the impulse that has come from the English side, because that impulse balancing what is coming up the other arm, passes down.

Mr. Justice Kennedy: It gives its message really by the force of meeting the other one?

Mr. Finlay: Yes.

Mr. Justice Kennedy: It meets the other one, and electrically the result of their meeting is to give the English message to the receiver?

Mr. Finlay: Precisely. The effect of the meeting is that it turns down the American electricity to do its work; it prevents it passing through the cable, and requests the current from America to do its work, which it does. The two currents neutralising one another in the cable, the English current agitates the English receiver, and the American current agitates the American receiver. For the working of such a system, absolute balance between the two arms of the bridge is essential. There must be an absolute balance established in respect of the resistance which the current passing up one arm of the bridge would encounter, as compared with what a current passing up the other arm would encounter. It is endeavoured to provide for that by having an artificial cable, presenting almost exactly the same resistance as the real cable, which goes under the sea, presents. The artificial cable so constructed as to represent the equivalent of the resistance of the submarine cable.

Sir R. Webster: Resistance and capacity.

Mr. Finlay: But it is, of course, necessary that there should be adjustments. You cannot have your artificial cable so exactly balancing the submarine cable that adjustment is not necessary, and the first instrument that is employed for the purpose of the adjustment is the rheostat. Then there are the condensers. The first function of the condensers is to accentuate the signalling. If only one side is signalling, the condensers that work together—I will take it from the American side—will be the two condensers on the arms of the bridge on the American side, and the condenser on the wire on which is situated the receiver on the English side, they will have the effect of accentuating the signalling. The importance of the patent of 1880 is that by the combination of the rheostat to the three condensers, one on each arm of the bridge, and one on the arm on which the receiver is situate, it enables you to get together two things which previously had been incompatible, namely, the greatest possible speeds in transmission with a perfect balance. For the purpose of facilitating the obtaining of a balance before this invention, telegraphists were constrained to employ very high resistances, going up as far as 2,000 ohms on each arm of the bridge. The object of this combination, which is the distinctive feature of the patent of 1880, was to attain the maximum of speed in working with a perfect balance to dispense with the high resistance, to dispense with all resistance in the arms of the bridge, to use the three sets of condensers in combination with one another, and with the rheostat which is at the point of junction of the arms of the bridge where the current comes from the battery. If your Lordship will now turn to the American patent of 1880, I think this will be intelligible. Mr. Alexander Muirhead says in his specification: "My invention relates to duplex telegraphs of the class worked on the bridge or differential system. Its object is more especially to reduce the retardation of the signals and thereby to increase the speed of transmission of submarine telegraph lines, which ends I attain by certain novel combinations and organisations of old instrumentalities set forth in the claims at the end of this specification."

Sir R. Webster: This is not the original duplex patent, but an improvement in it?

Mr. Finlay: Yes, this is an improvement. The signalling apparatus shown consists of a reversing key with a battery and a condenser. Then the specification goes on: "A rheostat of low resistance adjustable to varying resistances is interposed in the circuit between the earth and bridge coils for the finer adjustment of the duplex balance. The bridge coils are connected at one end with the rheostat, and at the other with the true and artificial lines or cables in the bridge circuit, between which is inserted a receiving apparatus consisting of a condenser or accumulator and a receiving instrument, generally Sir Wm. Thomson's recorder or mirror. In order to reduce the resistance of these bridge wires, without increasing their shunting effect on the receiving circuit between the true and artificial lines, I divide the sending condenser into two sections, and interpose one section in each of the bridge wires, thus separating them so as to prevent the shunting of the receiving circuit instead of leaving the condenser between the earth and the rheostat." That is part of the patent of 1880, and the term of the defendants' license was as long as the patent shall last. The nature of the attack the defendants make upon the patent is this: The patent was granted for a term of 17 years from 1880, therefore it will not expire until 1897. The defendants say the patent has come to an end under the American law, in this way, that it is identical with the English patent, whose term expired in July, 1891. They seek to show that, by the American law, the American patent being for the same invention which was the subject of the English patents, would come to an end at the same time with them. We object to this as not being competent to a licensee. We say it involves an attack upon the patent. Although a licensee might show that a patent had come to an end, he cannot bring it to an end by making an attack which involves a question of validity. In the second place, we say it is a complete mistake to suppose that the patent of 1880 is identical with either of the patents relied on in England. On the plaintiffs' side we have a very large and very illustrious body of scientific evidence that there is no identity between the English patents relied upon and the patent of 1880. The two patents relied on are the patents of 1886 and 1887. The original invention which they allege to be identical with the patent of 1880 is the patent granted in 1876. The American law is this: "No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid by reason of its having been first patented in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application. But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than 17 years." The invention which has formed the subject of a patent in another country can be patented in America, but the American patent expires with the foreign patent.

Mr. Justice Kennedy: The defendants seek to shorten your life by showing that in fact your patent was anticipated by an earlier patent.

Sir R. Webster: No.

Mr. Finlay: That earlier patent is the same as ours.

Mr. Justice Kennedy: That there was a prior patent.

Sir R. Webster: Not "anticipated."

Mr. Finlay: My friend shrinks from that expression.

Sir R. Webster: No, I do not.

Mr. Finlay: The defendants are endeavouring to attack the American patent by limiting its term.

Mr. Justice Kennedy: Which cannot be done unless it is shown the prior English patent was identical?

Mr. Finlay: Yes. If my friend's case were well founded, Mr. Alexander Muirhead could not have got the American patent at all, because the patent of 1876 is a patent to John Muirhead, based partly on a communication by Alexander Muirhead, and the patent of 1877 is a patent jointly to John and Alexander Muirhead. The defendants' contention is that the American Patent Office entirely overlooked the patents of 1876 and 1877. It is a mistake to suppose that these patents contain any anticipation of the patent of 1880. The patent of 1880 does not profess to be for new pieces of apparatus, but for a combination. It is a good patent for a combination, and is valid by American law, and I shall ask your Lordship to find as a matter of fact that it is not anticipated by either the patents of 1876 or 1877. We shall give general evidence that the combination shown in the patent of 1880 is new. If my friend succeeds in establishing that there was an anticipation, then he will be brought face to face with the difficulties on the points of law which I have suggested. There is one other point I must refer to; the defendants seek to apportion the royalty payable.

Mr. Justice Kennedy: That is a question of the construction of the agreement.

Mr. Finlay: Yes. The agreement provides for a distribution of the payments in the case of the cables breaking, or an interruption.

Mr. Justice Kennedy: If the 1880 patent remains they have to pay on all the cables?

Mr. Finlay: Yes; they are using our apparatus. The result of the trials was an astonishment. The speed effected by the patent was such, that the royalties payable under the agreement became considerably heavier than, I dare say, the defendants themselves had anticipated; but that is no reason for accelerating the demise of the patents which are yielding such valuable results. They are reaping the benefit of our invention, and we submit they are liable till 1897 to pay royalties, and we are entitled up to that time to reap the benefit of our invention.

Sir R. Webster: The patents of 1876 and 1877 are identical.

Mr. Finlay: Neither the patent of 1876 nor the patent of 1877 shows the combination of the double block of the condenser in the arms of the bridge, on the line of which the receiving apparatus is situated. The combination of these condensers with one another, and with the rheostat which is put at the junction of the arms of the bridge, is substantially the combination for which the patent of 1880 is taken out. My friend cannot show either in the patent of 1876 or 1877 that combination. The use of the rheostat in combination with these condensers is not shown in the patent of 1876.

Second Day (Thursday).

Prof. Silvanus Thompson, F.R.S., Professor, of the Technical College, Finsbury, examined by Mr. Bousfield, said he had had the three patents before him—the United States patent of 1880, and the two English patents of 1876 and 1877. These three patents are improvements upon the system of duplex telegraphy. The witness explained at great length the working of a system of duplex telegraphy. The successive improvements in duplexing had tended to increased sharpness of definition and increase of speed. In a long cable like the Atlantic cable the resistances in the arms of the bridge would be about a couple of thousand ohms each. In the plaintiffs' improvement the resistances in the bridge arms had been reduced because there had been interposed in each of the two arms a condenser. In the last plan the condensers dispensed with the resistances. Hitherto large resistances had been employed in those bridge arms. The point of novelty, as he understood it, was dispensing with the high resistance in the bridge arms by putting in condensers.

What function does the rheostat discharge in that arrangement?—It enables a small adjustment to be made.

Then what is the resistance which the rheostat induces—how much resistance would there be in that?—It is not specified in the specification—a small resistance—a mere correcting resistance.

Now, I will read the first claim. I will read you the elements of the combination: "The battery, the key, the adjustable rheostat, the sending condensers, each in a bridge wire, the cable or true line connected with one section of the condensers and the artificial line with the other, and the receiving instrument and its condenser." Do you find any such combination in either of the patents of 1876 or 1877?—I do not find the combination previously described.

Is there any rheostat used with the large resistances down in the 1876 patent?—There is no rheostat used with a bridge arm resistance in the 1876 patent.

Now, the second claim is: "The combination in a telegraphic circuit of the receiving instrument, the adjustable rheostat, the separate condensers in the bridge wire, one connecting with the true and the other with the artificial line, with the key, battery and condenser in the bridge or circuit between the two cables." Do you find

that combination described in either of the two former patents?—No; that is quite novel.

Cross-examined by Sir Richard Webster: Is a rheostat anything more than an adjustable resistance?—I would rather put it a readily adjustable resistance. I do not agree with the definition in "Houston's Electrical Dictionary" that, "Rheostat is a term signifying any adjustable resistance." I do not accept the word "any."

You say "readily adjustable?"—Yes.

I will take it as "readily;" and Wheatstone's receiver was a particular form of it, I think?—Yes; you merely had to turn a handle until you obtained the resistance required.

There is no description in the United States patent of 1880, nor in the patent of 1876, of any particular kind of rheostat?—No, nothing more than the drawings illustrate.

This (producing model rheostat) would be one of the class of rheostats, by which I mean a readily adjustable resistance, which would be used in duplex telegraphy, as known in 1880?—Yes.

Another would be a resistance box which might be operated by plugs?—No; I think that would not be called a rheostat.

Because it is not sufficiently readily adjustable?—Yes, and because a resistance box was so well known an article it would be called a resistance box, or a box of resistance coils.

Now, with regard to the condenser marked C 1, it has nothing to do with duplexing?—The duplexing would not be very good without it.

It has nothing to do with the making of the balance of the bridge so as to keep the receiver neutral?—*Per se* it has not.

It is merely an appendage used to get a sharp signal upon the receiver?—Yes.

The function of that condenser is to make the signal in the receiver assume a sharp definition instead of a blurred tail?—Yes.

In the same way the condenser near the key has a function with reference to sending the signal to America and getting sharp definition in America?—Yes.

Nothing to do with the balance bridge?—No. Condensers were used in that way long before the duplex was introduced. In the American patent the split condensers are represented a little nearer the rheostat, and a resistance is introduced between them and the point where the bridge goes across.

Fig. 1 of the American specification is stated to be the condition of duplexing prior to the improvement?—Not the only one.

In fig. 1 you will see that the condenser as an annex of the receiver, and a condenser as an annex or appendage to the sending instrument, are both shown?—Yes.

Take the specification of the 1876 patent. Duplex telegraphy was to a great extent new. In order to keep the proper relation between the cable and the artificial cable, must there not have been a means of adjusting the resistance in those two bridges?—No, not if you had the one on the artificial cable.

Was not that a well known and common way of having the adjustment on the bridge?—Yes.

Mr. Bousfield: I was going to object to that question. To take one point after another and attempt to break down the 1880 patent, on the ground that this, that, and the other was known, is not within the scope of the defendants, who are licensees, and therefore cannot attack the validity of this patent in any shape or form. They can only succeed by showing that the invention which is covered by the 1880 patent is to be found patented in either 1876 or 1877.

Mr. Justice Kennedy: Quite true. I agree to that, but I do not know that I can stop this cross-examination. In a scientific cross-examination of this kind, I could not presume to stop it at a particular point.

Sir R. Webster: I am cross-examining to show that to any electrician the two things are identical, and so far from disputing the validity of the 1880 patent or the 1876 patent, I am simply directing myself to the issue whether or not there is any substantial difference between the patents of 1880 and 1876.

Mr. Justice Kennedy: That is what I thought.

In further cross-examination by Sir R. Webster, the Witness said it was a perfectly well known method of keeping or adjusting the balance in 1876 to have a means of altering the resistance in the two bridge lines.

Taking fig. 2 of the plaintiffs' invention, do you not find split condensers put between the apex of the bridge and the artificial cable on the one side and the main cable on the other?—Yes, and at the same time he has removed the condenser which was near the key. What he has done is to take the second condenser away from the neighbourhood of the key, divided it into two parts, and insert this at the corners of the bridge.

From that point of view it is identical with what is in the plaintiffs' 1880 specification?—No, not identical.

Why not?—Because in this specification he suggests that the split condensers might be put on either side—either on the cable side or the land side of the receiving instrument.

But does it not show those condensers put between the apex of the bridge and end of the artificial cable in the one case, and of the main cable in the other?—Yes. In bridge patents it was a common way to adjust the resistances in the arms of the bridge.

In the American patent the function of the rheostat is to keep the balance or ratio of resistance equal, is it not?—To adjust the balance by altering the resistance.

Sir R. Webster proposed to cross-examine with regard to the details of the Canadian patents.

Mr. Bousfield objected. It would be more convenient to try the case entirely on the American patent of 1880. Unless the defendants could break down that particular patent, there was no use in their troubling about the others.

Mr. Justice Kennedy: We had better take the Canadian patents if there is any difference.

Sir R. Webster: My Lord, they know they are identical.

Mr. Bousfield: I know nothing about it. I have not read the Canadian patents. My friend had better reserve any questions about the Canadian patents.

Re-examined by Mr. Bousfield, Prof. Thompson said: As regards the combination of rheostat and bridge wires which is shown in the 1880 patent, I know of no better combination that can be used for duplex telegraphy.

Does that particular arrangement of the rheostat at the apex of the side wires of the bridge give the best results that you know of?—Yes; it affords such a very ready and reliable way of making the small change that is required.

Do you find in the 1876 patent any indication that this combination of the rheostat with the bridge wires in that way was known to the patentee under the 1876 patent—any indication in the specification that it was known?—The only indications relating to adjustments, such as those of a rheostat in the specification of 1876, are those that relate to similar adjustments effected, not on the bridge arms, or at their point of junction, but on the artificial cable.

The rheostat in the 1880 patent is for the purpose of obtaining a perfect balance, is it not?—Yes.

Is the arrangement of getting the balance in the 1876 patent as good a one as the 1880?—No, certainly not.

Lord Kelvin, in answer to Mr. Bousfield, said he had given a great deal of attention to the subject of sending signals by submarine cables, and had invented a good deal of apparatus which was practically used. There was no general knowledge of instruments used for duplexing submarine cables in 1876; he believed duplexing was done entirely by Messrs. Muirhead and Mr. Taylor; nobody except the plaintiffs was doing anything in duplexing submarine cables. He had read the United States patent of 1880, and observed that one element of the combination was the adjustable rheostat.

In your view, Lord Kelvin, is the use of that rheostat, and its use in the particular point indicated, a matter of importance?—Yes. It is of great importance to have a readily adjustable rheostat that can be adjusted without taking in or putting out plugs; that can be adjusted in an instant by hand and by moving a handle, so that the operator, for adjustment, does not require even to look at the rheostat. The sending clerk manipulates the instrument so that his signals do not disturb the receiving instrument.

As this rheostat is shown arranged in the 1880 patent, you would get what is called $r + r_1$ constant?—Yes.

That is, the shifting of the handle of the rheostat does not affect the sum of the resistances?—Yes.

Would that be the result if the rheostat were placed on one of the arms of the bridge?—No.

Is it of any importance to keep $r + r_1$ constant?—Of great importance. In fig. 3 of the American patent the only resistance on the bridge is the resistance in the rheostat. The signals might reduce the resistance on the one side to nothing, and put the whole resistance into another, or give any intermediate adjustment. The effect of this bridge upon the receiving instrument is kept constant by the large variations in the ratio, from nothing to infinity, in fact, which are effected.

Supposing the rheostat, for instance, were put in one of the arms of the bridge, would that effect the same result?—No. I regard the particular arrangement, as shown in the 1880 patent, as of great importance.

In the 1876 patent there are a number of different methods of obtaining a perfect balance?—Yes.

How do those methods compare with the methods shown in the 1880 patent?—The method preferred by the patentee in the 1876 patent shows the receiving instrument in connection between the plates of the bridge condenser, which are apart from the cable and artificial line, and next the apex of the bridge. That method of working would be wholly inconsistent with the great resistance effected in the 1880 patent, and found to be of so much importance.

Do you find any indication in the 1876 patent which would lead a person to place a rheostat at the junction of the bridge—the arms of the bridge—so as to get the results which you have described as flowing from the 1880 patent?—None whatever.

In this duplex arrangement success depends upon perfect balancing?—Yes. Speed depends upon the perfection of the balancing, and on the smallness of the resistance required to attain perfection.

When duplexing began to be applied to long cables, were great difficulties met with in getting the perfect balance?—Yes.

In your own view, does the actual success of these combinations depend on the relation in which the rheostat stands to the other elements of them?—Yes. I think that is proved by the great difficulty the patentees had in 1876 and 1877, as shown by the multiplicity of plans in the English patents to obtain a balance.

Sir Frederick Bramwell, in reply to Mr. Finlay, said: I summarise the combination found in the 1880 patent thus: The key, the battery, the sending condenser, the receiving condenser, the instrument or recorder, and the rheostat. I have read the English patent of 1876, and I do not find the same means described for attaining the results attained by the patent of 1880. That which is found in the 1876 patent is calculated to lead the mind of a reader away from that which I find in the patent of 1880. I find that the patentee, referring to his figures, puts forward fig. 2 as being the way where he puts his bridge condensers; and I understand him to use that figure for that purpose, and that purpose only, and to show that the bridge, by which I mean the cross-piece in which the receiving instrument is, may be either on the cable side of the condenser, or on the land side.

Will you point out in the patent of 1876 the means which you understand the patentee to suggest for maintaining the balance?—They are various. One includes what he calls "a double bridge." Another, the mode of attaching to the artificial cable at different places; and another, an electro-magnetic arrangement. A reader studying this specification would have his attention directed to the

use of one of these three methods, and directed away from the employmenta of rheostat at the apex of the triangle.

Is the employment of the rheostat at the apex, in your view, of importance?—Yes. It gives an extremely simple and ready mode of adjustment to the hand of the operator, and is certainly preferable to any one of the modes suggested in 1876. I quite agree that from 1876 the rheostat was a well-known instrument, but I do not agree that it was an obvious thing to employ it for the purpose for which it was employed in that 1880 patent; basing that answer upon the fact that in 1876 Mr. Muirhead apparently did not know how to do it. I mean from this specification it appears that was not obvious to one of the most competent men engaged in the business at that date.

Have you read the English patent of 1877?—Yes, I have; and I do not find in that the same means for attaining the results achieved by the patent of 1880.

Speaking generally, what was the nature of the means adopted in the 1877 patent?—Very largely an alteration of the point of attachment to the artificial line.

In practice, is the combination in the 1880 patent of the rheostat at the junction of the arms with condensers in the arms of the bridge and no resistances, and a condenser in the receiving instrument circuit, a valuable combination?—It appears so to me.

Cross-examined by Sir R. Webster: You have no personal knowledge of the working?—I have not. I cannot speak from practical experience. I only form an opinion upon it.

You said just now that it was evident Mr. Muirhead did not know of this in 1877. I presume you said that from your construction of the specification?—Well, hardly construction; but from the information that I, putting myself as a workman, derive from it.

Finding what you think you understand in the 1880 patent and not finding it in the 1876 patent, you drew the conclusion that the man who drew the 1880 did not know of the 1876. Is that what you mean?—I mean that, and more. It is not only that I do not find it in the 1876, but I find a variety of devices for obtaining the same end, which devices are different.

You think a rheostat could not have been included in the 1876 patent, because there are nine or ten other methods of arriving at the same end?—Yes, and because I do not find a rheostat there. I think these descriptions of the other methods are self-contained, and that every one of them would produce the balance without the addition of any adjusting instrument.

In fig. 1 of the 1880 patent, have you not identically the same arrangement shown as that in fig. 1 of the 1876 patent, except that in 1880 a rheostat at the bridge end is shown—in fig. 1 of 1876 a rheostat at the bridge end is not shown?—And, further, there is no condenser in the 1876 fig. 1 to the receiving instrument.

Do you find the only difference between fig. 1 of 1880 and fig. 1 of 1876 is, no rheostat or adjusting instrument in fig. 1 of 1876 and a rheostat at the bridge shown in fig. 1 of 1880?—Yes.

In 1876 a rheostat of this nature was an instrument commonly known for adjusting or altering the resistance in bridges?—Yes, it was.

In fig. 1 of 1876 you find no indication of how the balance is to be maintained?—I do not.

From beginning to end of the 1876 specification, you find no indication of the kind of adjusting instrument that is to be used anywhere?—No. I find no direction as to its nature, or as to how it is to be used, or where.

In the 1880 specification, beyond the word "rheostat" and the picture, there is nothing to indicate the particular class of resistance-adjusting instrument to be used?—Not beyond those words.

Do you know that the 1880 arrangement can be perfectly well worked with other kinds of resistance-altering instruments besides the rheostat?—I do not know, but I should think it quite possible.

Are there not many forms of readily adjusting resistance apparatus which, placed in that position, would do exactly the same work?—I think it is extremely possible that there are. No particular form occurs to me at the present moment.

Re-examined by Mr. Finlay, the Witness said that a great deal of the patent of 1876 was devoted to suggesting means for getting that balance more or less perfect, and all the suggestions were cumbrous ways of trying to get the result which was simply attained by the 1880 patent.

The Court then rose for the day.

(To be continued.)

Latimer Clark, Muirhead & Co.

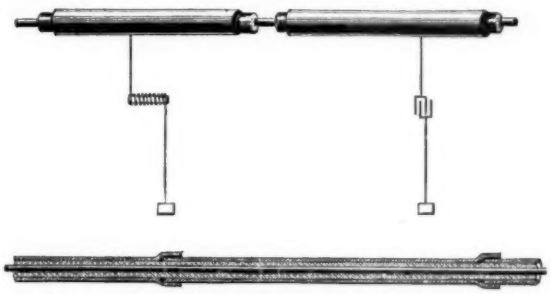
The petition of Willans & Robinson, Limited, for the compulsory winding up of Latimer Clark, Muirhead & Co., Limited, came again before Mr. Justice Vaughan Williams, in the Chancery Division, on Wednesday last. It was a petition by creditors for the compulsory winding up of an electric lighting company now in process of voluntary liquidation.

Mr. Justice Vaughan Williams, after listening to counsel's arguments, made a supervision order, which he thought would be as effective, if properly done, as a compulsory order. Liquidation to continue under the supervision of the court.

THE TESLA HIGH POTENTIAL CONDUCTOR.*

In order to prevent loss by dissipation or interference by induction on line conductors carrying high potential alternating currents they have in some instances, such as at Deptford, London, been insulated and inclosed in a continuous conducting sheathing which is connected with the ground by a good conducting path.

While conducing to the safety of the system, Mr. Tesla has found that the use of a conducting sheath or screen around the line conductors and well grounded, or even brought into proximity to external conductors or large bodies is attended by an actual, and generally a serious, loss of energy which is the greater, the greater the number of alternations and the higher the potential. He therefore maintains the sheath either entirely isolated or connected directly or inductively to the ground, through a path which will practically prevent the passage of currents over it. He has also found that when a continuous isolated sheath or screen is employed, there is greater liability to loss of energy by inductive action; for, unless the sheath or screen be considerably shorter than the current waves passing in the conductor, electromotive forces will be set up between different points in the sheath, which will result in the passage between such points of induced currents. Mr. Tesla, therefore, divides up the sheath or screen into short lengths, very much shorter than the wave lengths of the current used, so that the grounding of any one of such lengths or the approach thereto of a large body will result in an inappreciable loss, or at most a small local draining of the energy, while the tendency of currents to flow between different points in the sheath is effectually overcome. The function of the sheath as a static screen for preventing the dissipation of the electric energy, however, requires for its complete effectiveness an uninterrupted conducting partition or screen around the conductor. In the case of a sectional screen, this is obtained, by causing the ends of the insulated divisions or sections to overlap, and interposing insulating material between the overlapping portions.



Figs. 1 and 2.—The Tesla High Potential Conductor.

For transmitting currents of very high potential and very high frequency, Mr. Tesla provides between the sheath and the ground a path of very high ohmic resistance, or one containing a self-induction coil properly determined with respect to the existing conditions so that it will effect the desired result, or a condenser of very small capacity, as shown in fig 1. In such cases the sheathing or screen for practical purposes may be regarded as isolated from the ground, since by the character of the connection employed no appreciable loss results from the passage of current from the sheath to the ground. Fig. 2 shows the construction of an actual conductor of embodying the idea.

* New York *Electrical Engineer*.

NEW PATENTS—1894.

394a. "Improvements in the means of supplying forced draught to boiler furnaces when used in connection with steam turbines." C. A. Parsons. (Date claimed under Patents Rule 19, January 8th, 1894.) Dated February 20th.

3,519. "Improvements in chairs and rails for electric tramways underground channel." J. Wilkinson. Dated February 19th.

3,535. "Improvements in or relating to steam turbines." R. Harwood. (Communicated by R. H. Harwood, India.) Dated February 19th.

3,545. "An electrically controlled race game." G. G. Sarney. Dated February 19th.

3,548. "Improvements in and relating to electric arc lamps and mechanism for operating and controlling the same." W. Rowbotham. Dated February 19th.

3,589. "Improvements in electric arc lamps." R. A. Goodman and A. B. Barlow. Dated February 20th.

3,609. "Improvements in mechanical and electrical interlocking in connection with railway signalling." W. H. Elliott. Dated February 20th.

3,641. Improvements in ships' telegraph and indicating apparatus." T. Mudd. Dated February 20th.

3,652. "Improvements in the arrangements for working railway signals electrically." I. A. Timmis. Dated February 20th.

3,658. "Improvement in dynamo-electric machines." C. J. Hall. Dated February 20th. (*Complete.*)

3,667. "Improvements in telegraphic and telephonic apparatus." The Phonopore Company, Limited, and E. W. Smith. Dated February 20th.

3,674. "Improvements in primary galvanic batteries and in the liquids used therein." W. H. Longsdorf. (Communicated by G. Hewett, United States.) Dated February 20th.

3,688. "The electric-light cane." A. H. Johnston. Dated February 20th.

3,725. "Dry or semi-dry galvanic elements." T. Blackhurst. Dated February 21st.

3,727. "Improvements in magnetic separating machines." F. W. Harris and J. Andrews. Dated February 21st.

3,729 "Improvements in dynamo-electric machines." E. A. Claremont. Dated February 21st. (*Complete.*)

3,730 "Improvements in electric arc lamps." E. A. Claremont. Dated February 21st. (*Complete.*)

3,749. "Improvements in galvanic batteries." A. J. Boult. (Communicated by C. Cudell, I. Cudell, and M. Cudell, Germany.) Dated February 21st. (*Complete.*)

3,751. "Improvements in or relating to organs." R. Hope-Jones. Dated February 21st.

3,841. "Improvements in electric motors for vehicles." C. E. Grove. Dated February 22nd.

3,859. "Improvements in or relating to electric gas-lighting apparatus." W. P. Thompson. (Communicated by M. Ulmer, Germany.) Dated February 22nd.

3,860. "Improvements in dynamo-electric machines." A. Linard. Dated February 22nd.

3,863. "An improved electric arc lamp." A. E. Jones. Dated February 22nd.

3,897. "An improved bracket for telegraph or other insulators." W. J. Hancock. Dated February 23rd.

3,902. "A new method of applying electro-motors to lathe work." A. Chamberlain and G. Hookham. Dated February 23rd. (*Complete.*)

3,912. "An improved indicating apparatus or telegraph for use in signalling or exhibiting scores at cricket, billiards, or other games, or for other purposes." L. C. M. Blacker. Dated February 23rd.

3,922. "Improvements in or relating to the electro-decomposition of metals." M. Roskell. Dated February 23rd.

3,926. "Improvements in or applicable to dynamo-electric and other machines or apparatus for the purpose of preventing or retarding the passage of magnetic lines of force from or to such machines or apparatus." W. M. Mordey. Dated February 23rd.

3,931. "Improvements in apparatus for transforming continuous electric currents into alternating currents." F. S. F. Schneider. Dated February 23rd.

3,951. "Improvements in dynamo-electric machines." F. Richmond. Dated February 24th.

3,962. "Improvements in electrical switches." C. M. Dorman and R. A. Smith. Dated February 24th. (*Complete.*)

3,976. "A method of utilising the movements of the recorder coil or siphon connected thereto, or the movements of other apparatus used for receiving telegraphic messages through submarine cables or land-lines to automatically transmit telegraphic messages from one submarine cable or land-line to another submarine cable or land-line." J. Boyes. Dated February 24th.

3,986. "Improvements in electric motors." W. P. Thompson. (Communicated by the Ries Electric Specialty Company, United States). Dated 24th. (*Complete.*)

3,994. "An improved electrolytic process for covering or coating threads, fabrics, feathers, or other articles or materials with metal." A. J. Boult. (Communicated by A. Soret, France.) Dated February 24th.

4,005. "Dynamometer for mechanical musical instruments." K. Behrens. Dated February 24th. (*Complete.*)

4,006. "Improvements in or connected with gas and oil engines." W. von Pittler. Dated February 24th.

4,010. "Improvements in winding the armatures of dynamo-machines of the drum type." W. B. Esson. Dated February 24th.

4,021. "Improvements in telephone transmitters and arrangements for same." A. C. Brown. Dated February 24th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

206. "Improvements relating to apparatus for producing light by means of alternating electric currents." Sir D. L. Salomons, Bart., and L. Pyke. Dated January 4th. Has for its object, to construct an apparatus for producing electric illumination by means of the Geissler or glow effect, which apparatus shall be at once compact, safe and readily applicable to existing electric lighting installations served by alternating or pulsating currents. 6 claims.

2,161. "Heating liquids by electricity." L. B. Miller and M. W. Woods. Dated January 31st. Relates to apparatus for efficiently and conveniently utilising the heat given out by an incandescent lamp for heating liquids. 4 claims.

2,331. "Improvements in secondary electrical storage batteries or accumulators. N. H. Edgerton. (Under international convention.) Dated July 11th, 1892. Has for its object a cheap, simple and compact construction of battery, and at the same time to develop an increased voltage or tension of electrical energy. 3 claims.

5,987. "An improved method of reducing electrical induction on telephone and other circuits." G. E. Fletcher. Dated March 21st. Consists essentially in the use of condensation and induction to convey the required signals from the transmitter to the receiver. 2 claims.

6,907. "Improvements connected with the apparatus for raising or lowering the centre lights of chandeliers and electroliers." R. H. Best. Dated April 4th. The inventor employs a fitting of the nature of a long crank. He attaches the rod of the centre or reflector light to the part corresponding to the gudgeon or crank pin in a crank, and for the purpose of balancing the light, he lengthens the sides of the crank fitting in a line beyond its axle and away from the crank pin and by weighting these extensions balances the lamp in any position.

9,039. "Improvements in autographic or copying telegraph apparatus." S. P. Denison. Dated May 5th. The objects of the invention are: 1st. To simplify the transmitting portion of the apparatus in such manner as to permit of the preparation of a transmitting message fillet of the simplest possible form. 2nd. To devise a simple and efficient transmitting arm, and circuit connections adapted for use with this improved transmitting fillet. 3rd. The construction of adjustable devices for use in connection with the circuit controlling portion of the transmitter, which shall be more delicate of adjustment and of a more practical nature than are the corresponding parts described and shown in a prior patent. 4th. The construction of an improved receiving stylus which will vibrate over the receiving fillet with as little friction as possible, and avoid as far as may be unnecessary abrasion or tearing of the moistened fillet.

9,262. "Electric meters." O. Ericsson. Dated May 9th. The invention is an improvement upon the meter described in Patent No. 475,759, granted May 31st, 1892. 5 claims.

9,819. "Improvements in electric circuit controlling devices." W. P. Hall. Dated May 16th. Comprises two or more pairs of contact points connected with a circuit, any pair of which will act, when in one position, to exclude the current from the translating device, and when all the pairs of contacts are in their other position a path through the translating device will be provided. 10 claims.

11,464. "Improved galvano-electric belt or bandage." W. P. Thompson. (A communication by H. T. Biermanns, of Frankfort-on-the-Main.) Dated June 12th. Claim: A galvano-electric belt or bandage, consisting of a felt or flannel strip provided with strings or tapes and button holes, and when worn being impregnated with acetic acid, and on which strip are fastened, by means of a non-conducting material, zinc plates having eyelets or holes, and copper plates having hooks and holes, these parts being thus formed into a galvanic chain, and in which belt or bandage the current may be brought to different parts of the body by means of a gold cord or lace, substantially as described.

11,819. "Improvements in electric railway trolleys." E. H. Allen. (Under International Convention.) Dated November 6th, 1892. The object of the invention is to so construct a trolley and its arm that it will move freely and at the same time maintain a good contact. 3 claims.

12,374. "Improvements in portable electric lamps and batteries therefor." H. C. Gover. Dated June 23rd. Consists chiefly of improvements in the construction of lamps and batteries described in Specification No. 15,059, of 1892. 3 claims.

13,066. "Improvements in or relating to the manufacture of incandescent mantles or filaments for use in connection with gas or electric incandescent lamps." A. J. Boult. (A communication from O. H. Steuer, of Dresden.) Dated July 4th. Consists mainly in providing the incandescent material, *i.e.*, the minerals or metallic salts with a skeleton, capable of intermixing intimately and firmly with the said salts. This is done by employing a precious metal, such as gold or platinum, or also a mixture of both in the form of dust which has been precipitated from a solution containing a suitable acid. 6 claims.

13,858. "A galvanic element." A. Heil. Dated July 17th. Claim:—A galvanic element consisting of a silver electrode attached to a lead core sealed through the cover and embedded in a mixture of carbon and manganese dioxide, enclosed in a linen bag, a felt cylinder or diaphragm surrounding the same, a zinc electrode, and the electrolyte, substantially as described.

13,911. "An improved method of and apparatus for heating, welding, or working metals electrically." W. P. Thompson. (A communication by C. L. Coffin, of America.) Dated July 18th. Claims:—1. The described mode of electrically heating metal consisting in springing a voltaic arc between two electrodes one within the other, rotating said arc magnetically, and applying said arc to the article to be heated. 2. In an apparatus for electrically heating and welding by means of an electric arc, the combination, with two concentric electrodes, of a magnet for directing and steadying the arc, substantially as shown and described. 3. In an apparatus for heating and welding by means of the electric arc, the combination of two electrodes one within the other, a support for said electrodes and a magnet upon said support, and means for connecting said electrodes and magnet with the terminals of a generator of electricity, substantially as shown and described. 4. In an apparatus for heating and welding by means of the electric arc, the combination of two electrodes, one within the other, an electro-magnet surrounding said electrode and a support carrying said magnet and electrodes, substantially as shown and described.